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In Tribute to a Great Man

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PREFACE TO THE SEVENTH EDITION

THE preparation of this present edition has been undertaken entirely since the declaration of war. This has led to certain difficulties as enemy action has rendered some illustrations and notes inaccessible. The problem of the discussion of war surgery is one which we have kept prominently before us, and we have introduced a short appendix on War Surgery at the end of the first volume. This is in no sense comprehensive, for many subjects which can be reasonably considered as coming under the heading of war surgery were already present in the text. The appendix must therefore be regarded in the nature of an amplification of these articles, while we have transferred into it from elsewhere in the book the discussion of the treatment of "gas cases" and of certain aneurysms which are largely seen as sequelæ of war injuries.

The whole of the book has been completely and carefully revised, and many subjects entirely re-written. In particular, large alterations and additions have been made in the sections on cleft palate, blood grouping and transfusion, sympathetic surgery and injuries. It has been thought advisable to remove some of the preliminary discussion of bacteriology and the description of amputations which are only of historic interest.

The authors feel confident that the work will still maintain its place in the field of surgical literature as providing enough material for the student to pass his elementary and advanced examinations. It will also serve as a book of reference to the qualified practitioner.

There remains the pleasant task of acknowledging our thanks and indebtedness to those friends and colleagues who have assisted us in the preparation of this edition. The sections on ear, nose and throat surgery, ophthalmic surgery and anæsthesia have been revised and re-written by Mr. Neilson, Mr. Gimblett and Dr. Potter. Dr. Fildes having retired, Dr. Bertram Shires has kindly undertaken the task of revising the section on X-rays. Dr. T. Anwyl-Davies, Physician in charge of the Venereal Department at St. Thomas's Hospital, has fully revised all the sections dealing with venereal disease, and provided some extra illustrations for this part of the work; while the Surgery Departments of the Universities of Liverpool and Birmingham, and the Photographic Department at St. Thomas's Hospital have also supplied us with some excellent photographs.

Mr. Charles Rob, M.B., M.Ch. (Cantab.), F.R.C.S. (Eng.), Surgical Tutor and Registrar at St. Thomas's Hospital, has read all the proofs and to him we are indebted for several very valuable suggestions; while to Messrs. J. & A.

Churchill Ltd. and to Mr. J. Rivers of that firm we must acknowledge our gratitude for their usual courtesy, helpfulness and patience.

We feel that we cannot let this edition go to press without alluding to the death of the artist, Mr. Thornton Shiells. His skill in preparing drawings for illustrating medical and surgical publications was well known, and he was responsible for most of the illustrations in our original edition.

W. H. C. R.
P. H. M.

HARLEY STREET,
LONDON, W.1.

PREFACE TO THE FIRST EDITION

In producing this work the authors have had two main objects in view, the first being to place before the student a book which is sufficiently comprehensive to provide him with all that he will require in passing both his ordinary surgical examinations and any higher examinations to which he may aspire, such as the Fellowship of the College of Surgeons ; and the second, to present a book which may be of value as a work of reference to the medical practitioner.

Surgery is now a vast subject, and it has always fallen somewhat naturally into the divisions of Surgical Anatomy, Surgical Pathology, Diagnosis and Operative Surgery, together with all their side issues. We have recently come across the following quotation in a work of fiction with reference to certain imaginary members of the profession who are there described as " Men who, led to take up surgery by the hope of gain and notoriety, have given themselves no time to learn its scientific principles ; showy operators who diagnose with the knife and endeavour to dictate to nature and not to assist her." Feeling that there might be a certain modicum of truth in this description, we have endeavoured, as far as possible, to give a full account of the surgical pathology and the scientific side of the subject as well as the more practical details, such as diagnosis and treatment.

Surgical after-treatment is a subject which is often greatly neglected in both text-books and bedside teaching, and though, of course, it can only be learnt really thoroughly by actually having to undertake it, we have tried, as far as possible, to place before the reader reasonable and accepted methods for the after treatment of operation cases.

Modern medicine, and surgery also, are very much coloured by biological chemistry, and a multitude of chemical tests and laboratory examinations are now employed in connection with surgical cases. It is a deplorable fact that in many instances such methods are used to establish a diagnosis with complete neglect and disregard of the clinical aspects and personal subjective symptoms of the patient ; we feel that it cannot enhance the interests or the reputation of the profession if the clinical and human elements in surgery are lost sight of, and have therefore endeavoured to show that the practice of surgery is an art, and that it never can be an exact science, entirely relegated to the test tubes and appliances of a biochemical laboratory.

We have essayed as far as possible to give some account of the ways in which these various chemical processes and biological tests should be employed and of their relative values in diagnosis, but we have made no attempt to give in detail the methods of performing such tests. This is partly owing to limitation of space, but still more because we feel strongly that if the results of these complicated chapters in chemistry are to be of value in the diagnosis and treatment of patients, they must be performed by absolute experts, and it is not wise to encourage either the student or the practitioner to endeavour to perform them for himself.

We have made a practice throughout both volumes, where applicable, of prefacing each chapter with a short account of the applied surgical anatomy and physiology of the region or organ discussed. These sections are printed in small type, not in order in any way to detract from their importance, but from considerations of space, and to differentiate them from the pathological and clinical portions of the work.

An account of the various operations in surgery is not essentially part of a work on surgery, and there are many excellent books dealing with the subject. We have, nevertheless, included a short account of the salient points of all the more important operations with their indications and difficulties, in the hope that, for the student at any rate, it will render the book complete and increase its value.

In many instances there are methods of treatment and operations which, though very seldom practised nowadays, are nevertheless worthy of consideration for their classical associations and because of the resulting tendency for them to be used as examination tests. We have, therefore, as far as possible referred to all such obsolete methods, but in the shortest possible fashion, giving the reasons for their gradual disappearance from modern practice.

With the added object of rendering the work as complete as possible we have included short chapters on diseases of the eye, diseases of the ear, nose and throat, on anæsthetics, on X-rays in diagnosis and treatment, and on the surgical aspects of obstetrics and gynæcology. In each instance these chapters have been written more with a view to assisting those who are studying or practising general surgery rather than the specialities therein contained.

There remains the pleasant task of acknowledging our indebtedness and thanks to those of our colleagues and others who have assisted us in the preparation of this work.

Mr. R. H. O. B. Robinson, B.A., M.B., B.Ch. (Cantab.), F.R.C.S. (Eng.), Surgeon in Charge of Out-patients to St. Thomas's Hospital and Assistant Surgeon to the City of London Hospital for Diseases of the Chest, has written part of the four chapters on Injuries of Bones, Injuries of Joints, Injuries of the Upper Limb, and Injuries of the Lower Limb. He has also read through the whole of the proofs for us and given us many valuable suggestions.

Mr. W. H. Battle, F.R.C.S. (Eng.), Consulting Surgeon to St. Thomas's Hospital, to whom we were both House Surgeons, has very kindly placed the whole of his very large collection of clinical photographs and pictures at our disposal, and we have drawn many of our illustrations from this source.

Mr. D. F. A. Neilson, B.A. (Cantab.), F.R.C.S (Eng.), Assistant Surgeon to the Ear, Nose and Throat Department of St. Thomas's Hospital, Aural Surgeon to the Freemason's Hospital and London Fever Hospital, late Assistant Surgeon to the Ear, Nose and Throat Department of the Royal Free Hospital, and Registrar to the Ear, Nose and Throat Department of University College Hospital, has written the three chapters on Diseases of the Ear, Nose and Throat.

Mr. C. L. Gimblett, M.A., M.D., B.Ch. (Cantab.), F.R.C.S. (Eng.), M.R.C.P. (Lond.), Surgeon to the Royal Westminster Ophthalmic Hospital, and late Senior Ophthalmic Surgeon to the Royal Northern Hospital, has undertaken the whole of the chapter on Diseases of the Eye.

Dr. Geoffrey Fildes, M.B., Ch.B. (Vict. Manch.), D.M.R.E. (Cantab.), Physician in Charge of the Radiological Department at St. Thomas's Hospital, has written the chapter on X-rays in Diagnosis and Treatment.

Dr. A. F. Potter, Honorary Anæsthetist to St. Thomas's Hospital and to the Royal Albert Dock Hospital and late Hon. Asst. Anæsthetist to the Royal Dental Hospital, is responsible for the chapter on Anæsthesia.

We are also indebted to Mr. Richard Warren, M D., M.Ch. (Oxon.), F.R.C.S.

(Eng.), for permission to use certain illustrations from his work, "A Text-Book of Surgery."

To Professor Dudgeon, Dr. Bamforth, Dr. A. L. Urquhart, and Dr. John Taylor we are indebted for the loan of microscopic preparations and pathological material, and to the Museum Committee of St. Thomas's Hospital we owe our thanks for permission to make use of the specimens in the Shattock Museum.

From Colonel Harrison and Dr. T. Anwyl-Davies we have derived much help in the matter of the treatment of venereal diseases, and to the former we tender our thanks for permission to use several illustrations.

Prof. De Wesselow, Physician to and Professor of Medicine at St. Thomas's Hospital, has kindly assisted us with regard to the various tests for renal efficiency.

Dr. Dore, Consulting Physician to the Skin Department at St. Thomas's Hospital, has helped us greatly with advice and illustrations relating to Diseases of the Skin, and to Messrs. Millward and Yule we tender our thanks for photographs which they have taken for us.

We are indebted to Messrs. Allen and Hanbury for the loan of certain blocks.

Messrs. Thornton Shiells and Ford have greatly assisted us by the painstaking way in which they have produced drawings of microscopic slides and specimens, at the skill of which we can only marvel. We are also much indebted to Messrs. J. & A. Churchill for their help and care in the publication of the work.

W. H. C. R.
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THE SCIENCE AND PRACTICE OF SURGERY

CHAPTER I

INJURIES AND DISEASES OF THE BRAIN AND ITS MEMBRANES

Surgical Anatomy and Physiology. The brain is surrounded by the three membranes which together constitute the meninges. The outer membrane, the *Dura mater*, consists of a tough, outer fibrous layer, which is really the periosteum of the inside of the skull, and a softer inside serous layer lined with endothelial cells. In places these two layers split and in between them run the big venous sinuses, while between the dura mater and the bone are found the meningeal vessels. The dura also splits to form the cave of Meckel. Beneath the dura is the subdural space, which is narrow and really only a potential space, the dura being more or less closely applied to the middle membrane, the *Arachnoid mater.* This is a thin layer lying close to the brain, but not penetrating into its sulci, and it is in its turn separated by the subarachnoid space from the innermost membrane, the *Pia mater*, which is a thin and very vascular layer, closely applied to the surface of the brain and insinuating itself into all its sulci. In the subarachnoid space, which is subdivided by a network of fibrous tissue, we find the cerebrospinal fluid, this space being, at the base of the brain, enlarged in certain situations into wide spaces, full of cerebrospinal fluid and known as *cisternæ.*

Circulation of the Cerebrospinal Fluid. The cerebrospinal fluid is secreted by the choroid plexuses of the lateral ventricles, and this fluid is greatly increased by venous congestion in the cranial circulation or by obstruction of the vein of Galen. It has the property of setting up a protective reaction in any soft tissues other than nervous structures with which it comes in contact, and around any leak of cerebrospinal fluid into other tissues a new dura mater is rapidly formed. The fluid fills the ventricles and passes out into the cisterna magna and the general subarachnoid space through the foramina of Majendie, Key and Retzius in the roof of the fourth ventricle. From the base of the brain the fluid passes forward and upwards over the cerebral hemispheres, while a small amount passes down the spinal meninges. It is finally absorbed into the intracranial venous sinuses by means of the Pacchionian bodies and small arachnoid villi. The brain and spinal cord are surrounded by this fluid on all sides, while the central spinal canal also contains it. The inner surface of the dura mater is a serous membrane like the peritoneum but with a very limited power of forming adhesions, so that infection very readily spreads underneath it.

Each cranial nerve as it leaves the skull drags out with it a tubular prolongation of each of these membranes, which gradually fuse with the fibrous sheath of the nerve.

The Cerebral Circulation. The vascular arrangements within the skull are peculiar in many ways. For inasmuch as the skull is virtually a rigid box containing what may be regarded as an incompressible semi-fluid substance, the amount of blood flowing into the skull must always equal that flowing out, and as the vessels of the brain have no vasomotor control, changes in the amount of blood supplied to the brain are entirely effected by alterations in the pressure of the general circulation. So that a rise of general blood pressure will send more blood to the brain, while obstruction of the internal jugular veins, by which most of the blood leaves the skull, will diminish the circulation through the brain and increase the intracranial pressure. It is on these facts that the efficiency of injections of hypertonic saline in reducing intracranial pressure depends. The cerebrospinal fluid can flow backwards and forwards down into the spinal canal, and this can compensate to a slight degree for changes in pressure, provided they are gradual; thus a gradually increasing pressure on the brain may have little effect for some time, but a rapid increase of pressure cannot be compensated for and soon causes the brain to become anæmic. The arterioles of the brain are end-arteries, so that the blocking of any particular vessel threatens the vitality of the area which it supplies, though the main arteries anastomose freely before entering the brain. The effect of any general rise in the intracranial pressure is to force the cerebral hemispheres down upon the pons and medulla, and the latter structures in their turn through the foramen magnum and down upon the spinal cord. When cerebral pressure is very high, quite a marked cone may be produced by the forcing of the medulla and cerebellum down through the foramen magnum. The veins of the brain have no valves and are very thin: immediately on leaving the brain they enter the venous sinuses which are between the two layers of the dura mater, and thence most of the blood drains into the internal jugular veins.

The brain consists of an outer layer of grey matter, composed chiefly of nerve cells, while its inner portions consist of white matter, which is formed by long nerve filaments projecting from and connected with the nerve cells. The important nerve centres are therefore found chiefly in the outer layer of grey matter and also to a certain extent in masses of grey matter which are distributed in the deeper parts of the base of the brain.

Motor Centres and Tracts. The nerve cells which control the voluntary movements of the body are largely grouped together in one area known as the Motor Area, which is situated in the grey matter of the ascending frontal gyrus (precentral convolution), which lies immediately in front of the Fissure of Rolando; and this area passes right up to the mesial surface of the cerebral hemisphere where it is in contact with the Falx Cerebri (paracentral lobule), while it passes downwards as far as the Fissure of Sylvius. Every group of muscles is here represented by a regulating group of nerve cells, which are constant in position, the order of the groups of nerve cells in this convolution being roughly, from below upwards, those for the hand, arm, shoulder, trunk, hip, legs, and toes. Thus above the superior genu of this convolution are found the centres governing the leg, foot and perineum: the trunk centres are opposite this genu; the arm centres are immediately below it. Opposite the middle genu of the convolution lie the centres for the neck, while below it are those for the face, tongue and larynx. Movements of the eyes and head are represented rather further forward in the posterior part of the midfrontal gyrus. It must be remembered that certain neurologists hold that cerebral localisation is not as definite as this, and is a much more widely scattered phenomenon. The motor impulses pass down from the cortex by two tracts, the Pyramidal and the Rubrospinal, the latter carrying fibres which come from the cerebellum. The fibres for the *pyramidal tract* pass from the motor cells in the motor area through the centrum ovale to the internal capsule, where they are found in the anterior two-thirds of its posterior limb, the arrangement of the fibres at this point being, from before backwards, those for the face and eyes, those for the arm, and finally those for the leg. From here the pyramidal tract passes down the crus cerebri, the pons and the medulla, and in this part of its course many fibres pass away from the tract to communicate with the nuclei of the cranial nerves which lie in the pons and the medulla. In the lower half of the medulla the decussation of the pyramids is found, and here the greater part of the motor fibres cross to the opposite side and pass down the lateral column of the spinal cord to form the *crossed pyramidal tract*. A few fibres do not cross here, and these pass straight on down as the *direct pyramidal tract*, but these fibres also cross in the cord lower down.

The fibres of the *rubrospinal tract*, which are responsible for the preservation of muscular tone, originate in the cerebellum, where they form the efferent fibres of a reflex mechanism, the afferent fibres of which pass up from the cord into the cerebellum. From the cerebellum these fibres pass to the Red nucleus, and hence via the crus cerebri, into the rubrospinal tract itself in the lateral column of the spinal cord. It is thought that the rubrospinal tract controls the more automatic movements of the body, such as breathing and walking, while the pyramidal tract conveys impulses or the more skilled movements. In addition to this it is probable that the pyramidal tract conveys impulses which inhibit the muscular tone, while the rubrospinal tract conveys the impulses which keep up and incite muscle tone. These filaments (axons) from the motor cells finally end at different levels of the cord by breaking up into dendrites in the ordinary way, and where this occurs a communication is formed either directly or indirectly with the motor cells in the grey matter of the anterior horns of the cord. The axons of these anterior horn cells pass out of the anterior nerve roots as the motor filaments in the spinal nerves and finally end up in voluntary muscles. The upper system of cell, axon and dendrite reaching from the cortex to the grey matter of the cord is called the *upper motor neurone*, while the lower and similar system which leads the impulses on from where this upper neurone ends, as far as the voluntary muscle for which they are designated, is called the *lower motor neurone*. A destructive lesion of the upper neurone will lead to a spastic paralysis of the muscles concerned, with exaggerated deep reflexes, if the pyramidal tract only is involved. If the rubrospinal tract is also destroyed, as is seen in a total transverse lesion of the cord, the muscles will be flaccid and the deep reflexes lost, but in lesions of the upper neurone, whether spastic or flaccid, the nerve fibres do not degenerate, the nutrition of the muscles does not suffer greatly, only exhibiting wasting from disuse, nor do

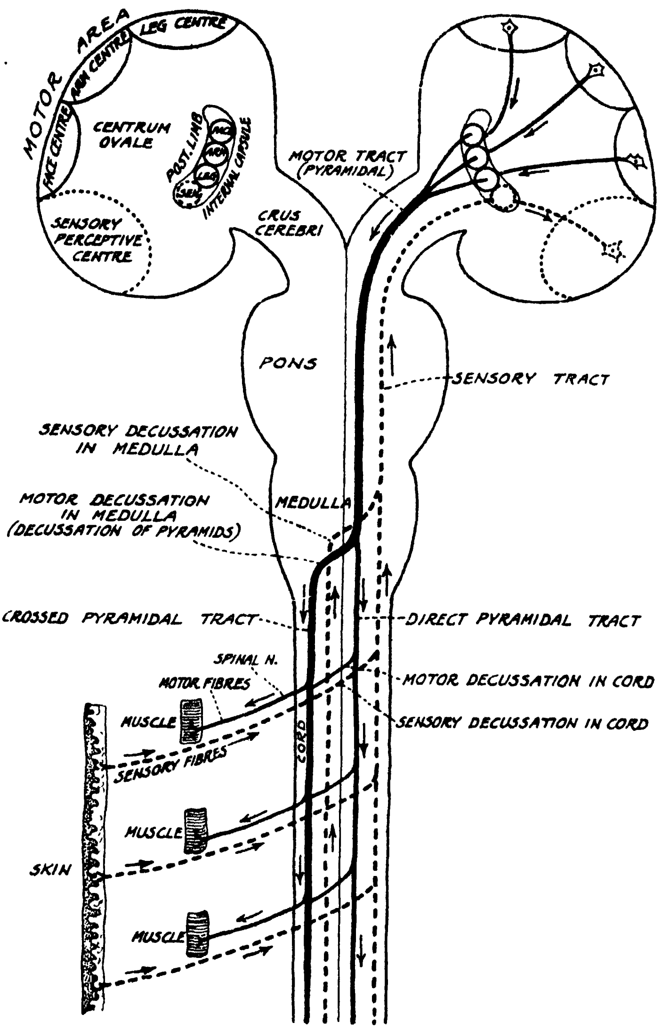

FIG. 1. A diagrammatic representation of the motor and sensory tracts in the brain and spinal cord.

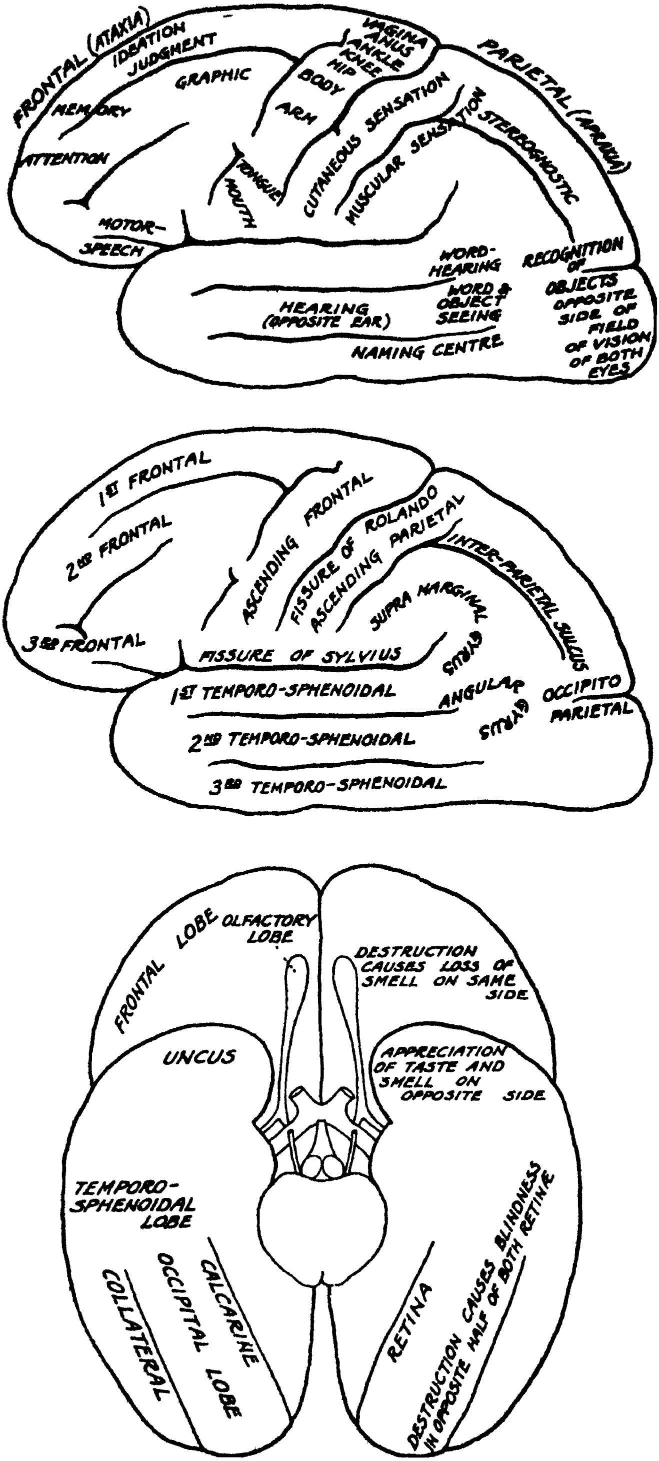

FIG. 2. Diagrams illustrating the position of important cerebral gyri and the localisation of certain important functions of the brain.

they develop the reaction of degeneration. If the lower neurone is involved by a lesion, the muscles are always flaccid and the deep reflexes lost, the nerve fibres degenerate, the muscles rapidly waste, and in a few days show the reaction of degeneration.

Sensory Centres and Tracts. There are several different kinds of sensory impulses which pass from the periphery of the body to the brain: they include the sensations of deep pressure, joint position, heat and cold, pain, light touch, discrimination of separate points close together and localisation of sensation. (For a fuller description of these see Vol. I., Chapter XII.) The fibres conveying all these sensations run up the peripheral nerves and pass into the posterior spinal nerve roots: here these fibres are connected with the cells in the ganglion on each posterior nerve root. From these ganglionic cells an axon proceeds into the spinal cord via the posterior root, and in the cord the main branch travels upwards, while one or two smaller branches are given off which pass downwards. The ascending fibres then pass up to the brain by two routes. Those conveying pain and temperature sense cross to the opposite side of the cord shortly after entering it, and then ascend in the *tract of Gowers*, passing through one or more secondary cell stations on their way: finally they pass by the Fillet to the Optic Thalamus; while the fibres conveying muscle and joint sense and sensations of light touch pass up in the posterior columns of the cord in the *tracts of Goll and Burdach* to the nucleus gracilis and cuneatus and the medulla: there they also cross to the opposite side and pass on to the optic thalamus. In the optic thalamus these fibres communicate with the fibres of other cells, whence axons pass directly to the sensory centres in the cortex, which are situated in the post-central (ascending parietal) convolution immediately behind the Fissure of Rolando and also to a certain extent in the immediately adjoining portions of the parietal lobe. In this part of their course these sensory fibres are found in the posterior limb of the internal capsule immediately behind the motor fibres of the leg.

Effects of Lesions. It must be remembered that the results of lesions of the nervous system vary greatly according to whether the affected part is irritated and stimulated or destroyed and put out of action; thus many lesions, such as a tumour or hæmorrhage, will affect the part of the brain concerned first of all by irritating it and only later on by destroying it. Irritative lesions of the motor system produce muscular spasms, twitchings, convulsions and rigidity, whilst in the sensory mechanism they cause pain, tingling and numbness. Destructive lesions of the motor system cause paralysis, which will involve the upper or the lower motor neurone as the case may be (see p. 3), while on the sensory side of the system such a destructive lesion will cause complete anæsthesia, loss of muscle sense, of pain, and of temperature sense. It must be remembered also that many lesions in the brain will cause destruction of one part of it and irritation of neighbouring parts, while the conditions of the circulation within the skull are unusual, so that the presence within it of an abnormal swelling, such as a tumour, may cause one portion of the brain to lose its function, owing to anæmia, and another portion to be hyper-excitable as a result of congestion. Irritative phenomena in the motor system are as a rule chiefly associated with lesions affecting the cortex: but they are also often seen in lesions affecting the tracts.

Special Centres. The cortical centres which control Vision are found in the occipital lobes around the calcarine fissure, being behind the parieto-occipital fissure which lies under the lambda, the centre on each side receiving fibres from the corresponding sides of both retinæ. Thus the destruction of the vision centre in one occipital lobe produces a homonymous hemianopia.

The Auditory centre is in the posterior half of the superior temporal convolution.

The centres for Smell and Taste are found in the uncus.

Speech and the understanding of speech, reading, its understanding, and writing are all methods of expression which are closely related to one another, and they depend upon the co-ordination of several different centres in the brain, namely the speech centre proper, the visual, the auditory and the writing centres. These centres are connected to each other by fibres known as association tracts which run in the white matter of the brain, and which pass just above the upper end of the Fissure of Sylvius, and it is lesions in this neighbourhood, and more especially on the left side, which give rise to Aphasia.

The frontal lobe has been called a silent area, as here sometimes extensive lesions will produce no symptoms, though in other instances they will be accompanied by changes in temperament or intelligence. It is possible also that at the front of the frontal lobe there is a centre which initiates voluntary movements, and this centre is probably to be found in the superior and middle left frontal convolutions in right-handed people.

Cerebral Localisation. There are several methods by which the various parts of the brain can be localised with relation to the surface of the skull, and in order to do this certain important bony points must be recognised. The Nasion is situated in the midline at the base of the nose, *i.e.*, the midpoint of the naso-frontal suture: the Inion is the external occipital protuberance which can easily be felt, and a line joining these points corresponds in direction to the Falx cerebri, and the superior longitudinal sinus. The point on this line where the parietal and frontal bones meet is called the Bregma, while the corresponding point where the parietal and occipital bones meet is the Lambda and is about 2½ inches above the Inion. At the side of the skull the following structures may be felt: the parietal eminence, the inferior temporal crest, which may be traced backwards from where it commences near the external angular frontal process, the external angular frontal process itself, and the malar tubercle just below it, the zygomatic process passing backwards towards the ear, the mastoid process behind the ear, with Macewen's suprameatal triangle just above and in front of it.

The lateral sinus commences at the Inion and goes with a gentle curve upwards to the posterior part of the upper half of the mastoid process. Thence it curves downwards nearly to the apex of this process.

Reid's base line is a line drawn backwards from the lower border of the orbit to the middle of the external auditory meatus, and this, when prolonged, runs just below the inion. The line lies almost completely below the level of the lateral sinus.

The Sylvian point, where the three limbs of the Sylvian fissure diverge, is 1½ inches above the zygoma and 1¼ inches behind the external angular frontal process: this very nearly corresponds with the Pterion. The posterior horizontal limb of the fissure runs from this point to a point ¾ inch below the most prominent part of the parietal eminence, while the vertical and horizontal limbs of the fissure pass directly upwards and directly forwards from this point for ¾ inch.

The external parieto-occipital and first temporo-sphenoidal fissures correspond to a line joining the malar tubercle and the lambda, the posterior and middle thirds of this line corresponding to these two fissures.

The Fissure of Rolando is marked out best by finding a point ½ inch behind the midpoint of the line from the nasion to the inion: this point is 2 inches behind the bregma. From this point a line should be drawn downwards and forwards at an angle of 67½° to the median line and this line should extend for about 3½ or 4 inches. The precentral convolution containing the motor area will then be found immediately in front of this line, and the sensory area will be immediately behind it, while it is useful to remember that the superior temporal crest to which the temporal fascia is attached, and which lies about ¼ inch above the inferior temporal crest, crosses this Rolandic line at a point which marks roughly the separation of the face and arm areas from one another.

The *middle meningeal artery*, which is a branch of the internal maxillary, is a vessel of some importance in connection with the surgery of the brain. It enters the skull through the foramen spinosum and divides into two branches at a point just above the midpoint of the zygoma. The anterior branch is the one more commonly injured, and the course of the vessel is mapped out by taking three points and joining them together: a point 1 inch above the zygoma, and 1 inch behind the external angular frontal process, a similar point 1½ inches above and behind these bony prominences, and a third point 2 inches above and behind the same prominences. In the lower part of this course the artery frequently runs into a canal within the bone, and it is therefore better when endeavouring to expose the artery to remove the trephine circle at the highest point and then to cut the bone away downwards. The posterior branch of the vessel will be found running backwards and parallel to the zygoma and about 1¼ inches above Reid's base line (see also Vol. I., Chapter X.)

It is sometimes necessary to tap the lateral ventricle, and this is best done by removing a trephine circle or boring a small hole 1¼ inches behind the external auditory meatus and 1¼ inches above Reid's base line. A trocar introduced here and directed towards the tip of the ear on the other side should strike the ventricle at a depth of about 2 inches from the surface.

Macewen's suprameatal triangle is the surface marking of the mastoid antrum, and this triangle is formed above by the supramastoid crest (the continuation backwards of the upper root of the zygoma), behind by a line drawn vertically upwards at the posterior border of the auditory meatus, and in front by the border of the external auditory meatus itself. The supramastoid crest corresponds with the level of the tegmen tympani and the base of the brain.

Other methods of mapping out the position of the various important structures can be employed. Reid has devised a system in which all measurements are referred to his base line, while Chiene has advocated another system of lines. For these the reader is referred to standard works on anatomy and surgical anatomy, while for a full account of the cerebral centres and the localising symptoms given by lesions of the brain, reference must be made to works on neurology.

Lumbar Puncture. The removal of cerebrospinal fluid from within the spinal meninges in the lumbar region by means of a hollow needle is of great value both as a means of diagnosis (by examination of the fluid withdrawn) and also in order to diminish excessive intracranial tension in various forms of disease, while it is equally valuable in spinal and in cerebral conditions. This puncture is best made with the patient lying on his left side, his back bent and his knees drawn up, so that his chin and his knees are as closely approximated as possible : some surgeons prefer to do it with the patient sitting. The skin in the lumbar region is painted with iodine and a stout long sterile needle containing a stylet, cut flush with the tip, is employed. The fourth lumbar spine is found easily, as it corresponds in level to the highest points of the iliac crests, and the needle should be introduced in the space between the lumbar vertebræ either immediately above or immediately below this spine (*i.e.*, the third or fourth space, the latter being the best if possible). The needle should be introduced strictly in the midline and should be given a slight inclination towards the patient's head. In most cases it will pass directly into the spinal theca at a depth of from 2 to 2½ inches, while if it encounters bone it should be withdrawn and introduced again. Once the needle is through the skin the stylet should be withdrawn and the needle then pushed onwards. When the spinal theca is pierced a slight suck will be heard and the cerebrospinal fluid will commence to flow out drop by drop if the tension is normal, while if the pressure is increased it will flow out in a continuous stream. If the fluid does not flow when the needle is thought to be safely in the theca, the stylet should be passed within the needle again to ensure that it is clear, while in some cases the passage within the needle of a smaller canula, whose end is cut square and without a point, will often cause the fluid to flow satisfactorily. The normal cerebrospinal fluid is absolutely clear, slightly alkaline, of specific gravity about 1006, with a trace of globulin, a few lymphocytes, some chlorides and traces of a substance which reduces Fehling's solution : antitoxins and opsonins appear to be absent from it. In addition to its value in diagnosis drugs may be introduced into the spinal theca by this means. Spinal anæsthesia is induced thus (see Vol. I., Chapter XXIV.), antitetanic serum or magnesium sulphate in the case of tetanus, salvarsanised serum or mercurial solutions in the case of the parasyphilitic infections of the nervous system have been introduced in this way, while in tuberculous and other forms of meningitis, in cerebral tumours and cerebral abscess, uræmia, and in prolonged coma after injuries, withdrawal of fluid by this means has often given rise to relief of such symptoms as headache, blindness, coma, or delirium. It is wise not to withdraw more than about 30 c.c., while in the case of cerebral tumour or conditions where the intracranial pressure is very greatly increased, lumbar puncture is not altogether free from the risk of sudden death, which is thought to be due to the medulla descending on to the foramen magnum and top of the spinal canal as the fluid is withdrawn, so that the vital centres are pressed upon. Lumbar puncture is often of use during operations upon the brain to diminish the pressure and prevent the brain being forcibly extruded when the dura is opened.

A few instances have been described in which after a lumbar puncture degeneration of the intervertebral discs and arthritis of the intervertebral joints have occurred.

As a means of diagnosis, examination of the fluid withdrawn is most valuable. In the case of injuries the presence or absence of blood in the fluid will determine at once whether any hæmorrhage that may be present is extra- or intra-dural. In every case of laceration of the brain or subdural hæmorrhage blood appears within a few hours in the fluid and is intimately mixed with it.

In acute meningitis the fluid withdrawn is turbid, contains an excess of albumen, and the organisms causing the meningitis can be cultured from it. Pus and an excess of leucocytes will be present.

In tuberculous meningitis the fluid is less turbid and contains less albumen but an excess of lymphocytes. There is often a thin clot-like opacity in it. In all forms of meningitis the pressure is increased. The bacillus of tuberculosis is not often discoverable.

Measurement of the spinal fluid pressure by lumbar puncture is of value in cases of spinal tumour. This is the basis of **Queckenstedt's test.** The spinal fluid pressure is measured by lumbar puncture at the top and bottom of the spinal canal and the differential changes in pressure are noted when (1) the jugular veins are compressed in the neck and (2) the patient strains.

In cases of cerebral or spinal tumour characteristic cells are occasionally found in the fluid, while in the case of a spinal tumour the injection of lipiodol followed by an X-ray photograph is an invaluable means of localisation. In cerebral abscess the fluid is normal, but in this case, and also in the case of a tumour, its tension will be greatly increased. Air is sometimes introduced into the spinal theca after the withdrawal of the fluid in the hope that it will ascend into the ventricles and demonstrate their size and shape in an X-ray plate (see p. 48).

In the examination of cerebral cases, traumatic or otherwise, a careful search must be made for any external lesion either of the scalp or the skull. The cranial and spinal nerves must be examined carefully and systematically, and a careful note made of the history with regard to fits and their onset, the patient's mental condition, and the state of the sphincters. The pulse, temperature, respiration and urine must be examined, the general nutrition enquired into and search made for any other lesions, such as middle-ear disease or bronchiectasis, which might have a bearing upon a cerebral condition.

Ventriculography. This method of investigating the shape of the ventricles is described on p. 48.

Arteriography is a method of investigating the shape and changes in the blood vessels of the brain or other parts of the body by means of an injection of thorotrast. It is described in Chapter X., Vol. I. (*vide* Plate I., Vol. I.).

INJURIES OF THE BRAIN AND ITS MEMBRANES

The brain is comparatively well protected from injury by the skull, with its smooth dome-like shape and its elastic walls and bony buttresses, by the movable scalp which lies over the skull, by the water jacket of cerebrospinal fluid in which it is contained, and by the membranes which surround it, which are attached to the skull at certain points and send projections in between the various lobes of the brain to support it. In all cases where an injury has occurred to the head, the clinical features, the treatment and the prognosis will depend almost entirely upon whether the brain and its surrounding membranes are damaged or not and whether infection of these important structures is likely to occur. Injuries of the brain and the skull essentially occur together, and one of these structures is very rarely seriously damaged without the other being involved to a certain extent also; but it must be remembered that, though any form or degree of injury to the one structure may be accompanied by any form or degree of injury to the other, it is the injury to the brain which is by far the most important consideration.

In considering traumatic lesions of the brain we shall find that the clinical and pathological manifestations do not appear always to correspond and coincide with one another, and that while the clinical manifestations may be divided roughly into two or three groups, and the pathological lesions encountered may be classed under three or four headings, the correspondence between the pathological variety of any injury and the group of clinical symptoms it gives rise to is not always the same. It is probable that whenever following an injury to the head a patient loses consciousness, some definite damage to the brain has occurred, though it may be difficult to detect in the post-mortem room, and all these injuries to the brain will take the form of greater or lesser degrees of bruising or laceration. It will also be found that the extent of the damage to the skull is often no indication as to the extent of the damage to the brain underneath, and very severe brain injuries may exist without any fracturing of the skull.

The main **pathological varieties of injuries** to the brain which are seen are as follows:—

(*a*) In mild cases, which have followed a blow on the head by a blunt object, and which probably have only been accompanied by the clinical symptoms of cerebral shock or concussion (see p. 10), scattered small petechial hæmorrhages will be found throughout the brain. These will be visible sometimes to the naked eye, and in other instances may only be microscopic. In addition to these, signs of degeneration will be present in some of the nerve cells, and there will be congestion of the base of the brain.

(*b*) If the injury to the brain is more severe, there will be larger areas of extravasated blood usually near the surface of the brain and in size varying from a pin's head to a walnut. They are often multiple and contain in their centre extravasated blood surrounded on the outside by an area in which the brain is red, softened and congested, and beyond this small petechial hæmorrhages will be found. Blood will be effused under the arachnoid mater, while the most severe extravasations are likely to be seen either under the point at which the skull is struck or at a point which is roughly opposite to this spot, in which case the injury is known as a " contre coup." The symptoms of such a condition will depend entirely upon the size and situation of the areas affected. Concussion and cerebral irritation (see p. 13) probably will be present, while irritation or paralysis of muscle groups, aphasia, deafness, or blindness will be found if the corresponding centres are involved. In a severe case the symptoms of compression of the brain (see p. 14) will be present, while it is a surprising fact that in many cases no localising physical signs are present at all, and it appears as though only silent areas had been involved. If, as sometimes happens, hæmorrhages have occurred into the important and vital centres in the pons or medulla, death is likely to ensue rapidly from deepening coma and respiratory and cardiac failure, and it is in these basal lesions that hyperpyrexia and Cheyne Stokes' breathing are especially seen.

(*c*) Actual tears and lacerations are not uncommon, and these usually will be found at the tips of the lobes or in the cerebellum, while in the case of a penetrating wound they may, of course, occur in any part of the brain. Giving rise as they do to diffuse hæmorrhage and increasing œdema, the clinical symptoms associated with them are usually those of severe cerebral irritation and later compression, while localising physical signs will be present according to the site of the injuries. Diffuse subdural hæmorrhage is usually present (see p. 24), and these injuries are serious and fatal. In such an injury the blood extravasated will sometimes find its way into the ventricles, usually the lateral ventricle, and when this occurs pulse, respiration and temperature all rise rapidly, generalised twitchings and convulsions occur, and death soon follows.

Any of the more severe degrees of injury to the brain substance will be accompanied after an hour or two by a traumatic œdema of the brain, both the arachnoid and the pial membranes also becoming œdematous. This œdema may remain localised to the site of the injury or may become generalised, and in either case it leads to a rise of pressure within the skull and causes cerebral irritation or compression (see p. 13).

Brain matter which has been lacerated or destroyed, in the process of healing is repaired by fibrous scar tissue, while the nerve cells and fibres undergo no regeneration whatsoever. Any portion of the brain destroyed, therefore, completely loses its function, though there is some evidence that neighbouring parts of the organ sometimes can assume and take over functions other than their own. Extravasations of blood inside or just outside the brain usually will be absorbed gradually, leaving a small amount of hard white scar tissue, but in other instances the blood will become encapsulated by a thin fibrous capsule and persist more or less indefinitely as a *hæmorrhagic cyst*, containing a yellow blood serum.

Apart from the actual local damage done to the brain when a head injury occurs, there is evidence that there is always a diffusion of violence throughout the whole organ. It must be remembered that when part of the skull is struck, whether it is fractured or not, it is momentarily indented, and, containing as it does what is virtually an incompressible fluid, such a momentary indentation is accompanied by a very great rise of pressure throughout the whole skull of very short duration, which in its turn sets up violent waves, stresses and strains in the cerebrospinal fluid which surrounds the brain and fills the ventricles. This sudden rise of pressure within the skull compresses the brain instantaneously and forces blood out of it, wringing it like a sponge and giving rise to a severe anæmia of very short duration, while waves and variations in pressure in the cerebrospinal fluid may lacerate vessels at a distance, shock and damage important centres and areas, and produce the scattered petechial hæmorrhages which are seen to occur. These two phenomena of instantaneous anæmia and diffused stresses and strains probably account in many cases for the production of injuries away from the point struck, and also for what may be called the generalised clinical manifestations of such injuries, which we shall describe now under the heading of cerebral concussion, cerebral irritation and cerebral compression. It must be remembered that these three conditions are simply clinical conditions, which in many cases merge into one another or are co-existent, and that their pathology is not only uncertain but that the gross anatomical lesions associated with them will vary greatly, from one case to another.

In addition to these three groups of general symptoms, many localising signs and symptoms may be present, depending upon what portions of the brain are bruised, lacerated or involved in a hæmorrhage, but these localising features are frequently masked, at first at any rate, by one or other of the three conditions about to be described.

Concussion of the Brain. This condition, which is popularly known as "stunning," is a clinical condition which is really very similar to that of acute shock, the symptoms in this case being produced by violence acting directly upon the brain instead of being due to impulses transmitted thereto by afferent nerves.

The pathological changes found in a case which has been subjected to concussion alone are very similar to those which occur in shock (see Vol. I., Chapter IV.), while in addition in many cases the brain presents multiple minute punctiform hæmorrhages and signs of congestion at its base. Often severe bruising and lacerations of the brain are present, but when this is so the case can not be regarded as one of pure concussion; in most instances of uncomplicated concussion the changes found in the brain are those described in Group (*a*) on p. 9, and the way in which these changes and symptoms are produced is uncertain. They bear no relation whatever to the locality of the injury, and therefore it is unlikely there is any truth in the theories that they are due to paralysis of the vasomotor centre or to stimulation of the vagal centres or to direct trauma to the brain itself. Inasmuch as the symptoms resemble a more or less total temporary cessation of all functions of the brain, it is probable that they are caused either by the severe temporary anæmia of the brain described above, or else by the waves of cerebrospinal fluid which the injury sets in motion, which flow from the lateral ventricles into the fourth ventricle, and also in the sub-arachnoid space, and reaching the pons and medulla affect both them and the restiform bodies, with their vital centres. Another theory has been advanced that "a molecular disturbance of the brain cells" causes the symptoms, but this means nothing. It must be remembered that concussion can be associated with any form of injury to the skull, while quite commonly it will be found to occur without any bony injury at all. Very few patients die from pure and uncomplicated concussion, and hence the opportunity of observing pathological changes associated with the uncomplicated condition are rare.

Clinical Features. The symptoms vary according to the severity of the violence, and to whether only the higher centres are affected or the lower medullary centres involved as well. In mild cases there is no loss of consciousness, but the patient feels giddy, dazed and sick for a few seconds and may fall to the ground. Here only the higher centres are affected, but in some cases automatism may occur, the patient having no subsequent memory of his apparently rational sayings and doings. He will remain mentally confused for rather longer and will sometimes vomit once or twice, but there will be no physical signs detectable, and after a minute or so he will have recovered completely, except that he feels a bit shaken. In a more severe case, where the medullary centres are also involved, he falls to the ground completely unconscious; occasionally shouting at him will rouse him, but more commonly he lies completely comatose with his muscles relaxed, his eyes closed, and the conjunctivæ insensitive; his pupils may be contracted and react to light, or in severe cases will be dilated and motionless, but if the condition is one of uncomplicated concussion they will always be equal. He is pale, cold and clammy, with a slow and shallow respiration, while the pulse is weak and fluttering, sometimes slow and sometimes rapid, often irregular; the sphincters are relaxed, so that incontinence may occur. The reflexes completely disappear at first, soon returning in a sluggish form, while the temperature is subnormal and remains so for some time.

It must be remembered that after any blow on the head concussion to a greater or lesser degree may follow as the immediate result, and this is so equally whether the skull is fractured or not, and whether the brain is gravely damaged or not, but the only cases which can be accepted as pure and uncomplicated concussion are those in which there is no gross damage to the brain and where the pathological changes are at most confined to the minute hæmorrhages described above. The commonest instance of a pure and uncomplicated concussion is a knock-out blow when boxing, where the patient is completely unconscious for a short time and rapidly recovers. After concussion has occurred, therefore, as the immediate result of a cranial injury, one of three things may happen :—

(*a*) The coma may deepen rapidly, the pulse disappear and the patient die within a few minutes. In some instances death is practically instantaneous.

(*b*) Where grave damage to the brain or its membranes is present the patient may pass without regaining consciousness from his state of concussion into a condition which is due to other and graver complications, such as cerebral laceration, intracranial hæmorrhage, infection, etc., and when this is so the symptoms known as cerebral irritation or cerebral compression will set in. In other instances of this kind there will be a lucid interval (see p. 22), when the patient recovers from his concussion and then passes into coma again as the result of these other more serious lesions.

(c) If the case is one of pure and uncomplicated concussion, death is very rare and a stage of reaction will soon set in, so that after a few minutes, or at most an hour or so, consciousness will return gradually. This will be heralded by an increase of pulse and respiration rate, by the patient moving and turning about and paying attention to various stimuli, while often vomiting will occur as the result of cerebral hyperæmia. The pupils become contracted, the reflexes brisk, and he becomes more rational, while the temperature will rise to 99° or 100°, and he will complain of headache and often become restless. It must be remembered that pure and uncomplicated concussion lasts only a short time and does not lead to prolonged unconsciousness, and that if this latter condition is present, we are dealing with some other and more grave condition. After the stage of reaction is complete and consciousness is restored, it is not unusual to find a subnormal temperature of 97°, a slow pulse (40 to 50), constipation, headache and sleeplessness for one or two weeks. By the end of two weeks in most cases he will have completely recovered, but there are several unpleasant sequelæ which are sometimes found to persist for a long time after a severe case. It frequently happens that the patient has completely forgotten the accident and events for a short period both before and after it, while in other cases a permanent loss of memory occurs or even persistent mental impairment. Sometimes it will be found that headache, weakness, irritability and lack of concentration persist for weeks and months, this group of symptoms being known by the somewhat unsatisfactory name of **Traumatic Neurasthenia.** Changes in character and temperament occur in other instances, and some patients after concussion will become unusually susceptible to the heat of the sun or to alcohol. More serious sequelæ are sometimes found, and loss of hearing, vision, or speech are seen, while the mental instability described above sometimes will pass into a definite delusional or melancholic insanity ; but the probability is that these severe sequelæ only occur after cases which are not uncomplicated concussion, but in which there are definite local esions in the brain.

The prognosis of any case of concussion, even the mildest, always must be guarded, as it is difficult to be certain in the early stages how much damage has been done to the brain, while if unconsciousness has been present the condition is always serious and must be followed by prolonged rest.

Treatment. The immediate treatment very closely resembles that for collapse (see Vol. I., Chapter IV.). The patient is put to bed and kept warm, the head kept low and the foot of the bed raised if necessary. If he is restless or violent, constant watching and gentle restraint will be necessary, and it should ever be borne in mind that this restlessness may be due to a desire to empty a full bladder or rectum, which act will be succeeded by a period of quiet repose. Stimulants should be avoided unless the patient is in extremis, as they may give rise to intracranial hæmorrhage. When reaction sets in and consciousness returns, the head should be raised to diminish the blood supply to the brain ; the patient may be given hot drinks and must be kept absolutely quiet in a silent and darkened room. Once the reaction is definitely established, a purge should be given in the form of calomel or croton oil, and he should be put upon a light diet. Shaving the head, icebags, Leiters' tubes, venesection, or the application of leeches are of very doubtful benefit. He should stay quietly in bed on a light diet without any worries or irritation for at least a fortnight and usually more, and every means be adopted to provide his brain with rest. Those who work with their brain will require a longer rest and more prolonged after-care than manual workers.

The administration of hypertonic saline solution is most valuable in promoting the reabsorption of cerebrospinal fluid and lowering intracranial tension; it may thus relieve headache, irritability and coma. ℥vj of a 25 per cent. solution of magnesium sulphate should be run slowly into the rectum twice a day and little fluid be given by the mouth. In urgent cases 70 c.c. of a 15 per cent. solution of sodium chloride or of 50 per cent. glucose solution can be given intravenously. If this fails to restore consciousness and unconsciousness is prolonged, so that it is probable that some graver condition exists, operative treatment (see p. 23) may have to be undertaken. Lumbar puncture in this case will be found useful, both as a means of diagnosis (see p. 7), and also because it will sometimes restore consciousness. A purge should be given while still unconscious, and above all the state of the bladder must be watched, as probably catheterisation will be necessary. Nourishment will have to be given in this case either by a spoon, a nasal tube, or by the rectum. Absolute quiet is just as important when the patient is unconscious as when he is conscious. In some cases there will be restlessness or delirium, and then morphia will be found useful, but this drug should be avoided in all head cases as far as possible, and often attention to a full bladder or loaded rectum is all that is necessary to quieten a restless patient.

Cerebral Irritation. This is a clinical condition which sometimes follows moderately severe injuries of the head after the initial concussion has passed off. Its signs and symptoms are essentially general and point to no local damaged area in the brain, though they may be accompanied by vague, localising features. It is particularly liable to follow upon injuries in the frontal, temporal or parietal regions, and pathologically it is caused by minor degrees of laceration of the brain, which are accompanied after a few hours by a certain amount of general cerebral œdema and hyperæmia. The symptoms do not as a rule commence for twelve or twenty-four hours after the accident, and when the condition has developed the patient assumes a position of general flexion, lying curled up on his side, never on his back, with his body bent forwards and knees drawn up, his legs, arms and fingers also flexed. He never stretches himself out, but is restless and tosses himself about, especially when disturbed. His eyes are kept shut and he resists any effort made to open them, while there is marked photophobia and, if seen, the pupils are equal and contracted. His skin is pale and his pulse feeble and slow, usually below 70, while his breathing is quiet and regular, not stertorous. The temperature will be slightly raised, and in most cases there is no incontinence, though occasionally it will be found that retention needs a catheter. Mentally his condition is peculiar; he is semi-conscious and pays no attention to what is happening unless disturbed or shouted at, but when this occurs he appears highly irritable, frowning, muttering or growling, grinding his teeth and flinging himself about, while if he answers when spoken to his language consists of expletives; usually he will take liquid food from a feeder. This condition often lasts a long time, from four or five days up to two or three weeks, and then improvement commences; the flexion passes off and he stretches himself out; he becomes less irritable, while his pulse improves and his temperature comes down. The mind is then often found to be weak and his condition fatuous; sometimes his memory is lost, both for events and things, while in other cases he is garrulous and excitable and will not stop talking. Recovery is very slow and may take several months. Frequently it will be perfect, though in some instances there will be permanent effects as the result of local injuries to the brain.

Treatment. The treatment is the same as that for concussion and consists in keeping the patient absolutely quiet in a darkened room on a light and nourishing diet. If very noisy or excitable, sedatives should be used, but opium products are better avoided. Careful nursing and feeding will be necessary, with attention to the bowels and the bladder, while rest must be very prolonged.

Compression of the Brain. This is also a group of clinical symptoms due to an excessive rise in intracranial pressure sufficient to disturb the functions of the brain. Such an increase of tension may be due :—

(*a*) To a hæmorrhage within the skull, either outside the membranes, inside them, or within the brain substance itself.

(*b*) To the pressure of depressed bone fragments or of a foreign body following an injury, though in this case it is probable that the pressure increase is due more largely to hæmorrhage than to the depressed bony fragments, or the foreign body itself.

(*c*) To acute spreading œdema of the brain (see p. 9).

(*d*) To an accumulation of inflammatory products which may be diffused throughout the meninges or form a local abscess.

(*e*) To the presence of tumours either due to new growths, to gummata or tuberculomata (see later).

The rapidity with which symptoms of compression appear vary greatly. In the case of a hæmorrhage, especially if extradural, there may be a lucid interval after the patient has recovered from his concussion before the symptoms of compression set in. If due to cerebral œdema it may not come on for some hours ; when due to an abscess it will take some days or weeks, and in the case of a tumour may take months or years. When an increase in the bulk of the intracranial contents occurs, displacement of cerebrospinal fluid from the skull into the vertebral canal will permit of a certain amount of compensation, provided the increase of intracranial tension is slow. This compensation is, however, very limited, and if the rise of pressure continues it soon will give rise to symptoms, the cortical centres being usually involved first and the medulla last. The effects of the pressure are most felt upon the capillaries of the brain, so that the circulation and nutrition of the brain tissue are interfered with. Since such an increase of intracranial tension is nearly always due to a local cause, it follows that those parts of the brain which are nearest to the compressing agent are affected first; they are at first irritated, and then later lose their function as a result of the anæmia which the pressure produces ; the near-by portions of the brain are first congested and thereby rendered hyperexcitable and later, in their turn, become paralysed, and it is thus not until the late stages that the medulla and deeper parts of the brain become involved. Thus involvement of the respiratory, vagus, vaso-motor, vomiting and cardiac centres will occur late, and such symptoms as slowing of the pulse, Cheyne Stokes' respiration and vomiting are signs that the compression has advanced to a considerable degree. It must be remembered that whatever and wherever the compressing agent is, the general symptoms of compression it produces will be roughly the same, though varying in intensity and rapidity of onset. Focal symptoms which are present in the early stages, and are due to the irritation of the compressing agent, will of course depend upon its site and nature. The condition is sometimes known as acute or chronic compression, according to its rapidity.

Clinical Features. The early symptoms of compression of the brain may be difficult to recognise, for they are of an entirely different kind to those of the fully-established condition. *The first signs will be due to local irritation by the compressing agent of the centres which lie near to it, and it is in this early stage that the condition should be recognised if possible.* In this early stage, though some degree of general compression is present, the compensatory mechanism referred to above is still acting, so that no general symptoms are produced. The symptoms and signs will then gradually increase, passing on to paralysis of the centres first irritated and irritation of other neighbouring centres, soon involved in their turn by paralysis, while simultaneously the development of what may be called the general signs and symptoms occurs. We are here dealing only with compression due to traumatic conditions, and thus in nearly every instance the symptoms will follow upon those of a preliminary concussion, either with or without a lucid interval. The first general symptoms are a dull headache, vertigo, restlessness, mental dulness or sometimes excitability, while vomiting sets in and the temperature will become subnormal. The brain substance itself not being sensitive, this headache must be due to pressure upon or stretching of the dura mater. As the pressure continues to increase any localising paralytic symptoms become more marked, and the patient gradually becomes unconscious. The blood pressure is high and the pulse is slow and full, dropping sometimes to 30 or 40 ; vomiting is more marked, the respirations slow, deep and stertorous, while the lips and cheeks will be puffed in and out. Sometimes there will be cyanosis and distension of the veins of the eyelids. The coma becomes so deep that nothing will rouse the patient, and he lies on his back motionless, with his limbs flaccid and all reflexes abolished. In the later stages the respiration becomes irregular and of the Cheyne Stokes' type, while it is usually from respiratory failure that death occurs. When the condition is very advanced and the medullary centres fail the pulse will become rapid and irregular and the temperature will rise, sometimes becoming very high. If it rises above 104° the condition will almost certainly prove fatal, while in other instances, especially where a basal lesion is present, a cerebral hyperpyrexia occurs, and shortly before the end the temperature will rise to 108° or more. Either retention of urine or incontinence of both urine and fæces will be found. Such localising symptoms as there may have been at the beginning, namely, twitching, fits, and paralysis of muscle groups, will by now have spread and ultimately disappeared, as the coma becomes deep. Pupillary changes will be present: in the earlier stages their nature will depend upon the site and variety of the compressing lesion, but in the later stages, at first on one side and then on the other, the pupil will become fully dilated and irresponsive to light, while examination of the optic discs will show swelling and engorgement of the vessels. A fuller account of the pupillary changes will be found on pp. 22 and 23.

Shortly before death occurs the coma becomes very deep and there will be generalised, sensory and muscular paralysis. The onset of Cheyne Stokes' respiration shows that death is near, while if the condition has lasted for several days it is probable that some degree of hypostatic pneumonia will set in and accelerate the end.

Differential Diagnosis. When a full history of the case can be obtained and an account of the accident elicited, there is as a rule little difficulty in the diagnosis of cerebral compression, but in many cases where a patient is found unconscious in the street, or under other circumstances where no history can be obtained, difficulties will arise, and this is more likely to be the case where no serious lesion of the skull or scalp can be seen; while if lesions on the head are discoverable, it must be remembered that it is quite possible that he has become unconscious from some other cause, such as apoplexy, and sustained the injuries in falling down subsequently. Other common causes of unconsciousness besides injury are cerebral hæmorrhage, cerebral embolism, alcohol, opium and other forms of poisoning, epilepsy, uræmia, diabetes, sunstroke, hysteria, cerebral malaria, meningitis, and the presence of various gross lesions such as cerebral tumour or abscess. It is scarcely necessary to mention that an unconscious man who smells of alcohol is not necessarily drunk, while it will sometimes be found that more than one of the above conditions may be present, as for instance when a drunken man falls and fractures his skull. A most careful examination therefore will have to be made, and *if there is the least doubt as to the condition present, the patient must be detained in hospital.* In many cases it is impossible to give a definite diagnosis for some hours, and when this is so the patient is much safer in a hospital ward than a police cell. If possible, inquiries should be made as to how the patient was found, whether blood or vomit was present near him or any evidence pointing to an accident. He should then be thoroughly examined, the skull and scalp first being searched for any sign of an injury, and in this case a lumbar puncture may be of assistance. The pulse, temperature, respiration, tongue and smell of the breath should be noted, while a complete examination of the nervous system as far as is possible in an unconscious patient should be undertaken. The pupils especially should be examined, as in opium poisoning or pontine hæmorrhage they are small and pin-point, though equal; in alcoholism they are usually dilated. Inequality in the pupils, in the reflexes or the muscular power and tone on the two sides of the body almost certainly indicates a unilateral lesion within the skull. Special attention should be paid to the movements of the eyeballs and the state of the optic discs. The urine must be drawn off and examined for albumen and sugar, and in doubtful cases the stomach contents washed out and examined for narcotic poisons; the feet should be examined for œdema. In the coma of uræmia or diabetes there is as a rule no stertor, albumen or sugar is present in the urine, but no paralysis or difference between the two sides of the body. The breath may have a characteristic smell, while other suggestive changes may be present in the heart or vessels. Similarly in the case of apoplexy or cerebral embolism, though here localising symptoms will be present, signs of arterial degeneration and of cardiac hypertrophy or a history of a previous apoplectic stroke will lead us to think that the lesion is not traumatic. A history that the patient is an epileptic renders the diagnosis of epileptic coma highly probable.

It must be remembered that in acute alcoholism the patient is not completely unconscious or paralysed; there is no difference between the physical signs on the two sides of the body, and washing out the stomach and other appropriate treatment will soon cause an improvement. In the case of the man brought in violent, struggling and uncontrollable, and thought to be "fighting drunk," it must be remembered that certain forms of intracranial hæmorrhage produce in their early stages a stimulation of the mental and cortical centres which will closely resemble this condition, and tragedies have occurred in such cases, when patients who have been thought to be uproariously drunk have been sent to the police station, and found there the next morning dead of cerebral compression.

Treatment. Treatment in this condition consists in removing the cause of the compression, and in most cases this will entail operation. According to the circumstances, simple decompression, removal of a cerebral tumour, drainage of a cerebral abscess, the ligature of bleeding vessels, the removal of depressed bone or of foreign bodies or of collections of blood clot will be required; and in many cases such operative treatment, especially in instances where the condition is due to injury, is very urgent (see p. 23). If operation is contra-indicated, lumbar puncture may give relief, while if this fails the treatment will be the same as that of concussion. The patient must be kept quiet in a dark room, the diet, bowels and bladder being attended to, and falling back of the tongue watched for. The head should be kept raised and cool, while feeding may be necessary by a rectal or nasal tube. As in all cases of head injury, urotropin should be given three times a day in 10-grain doses. Sulphanilamide may be useful if an infection is likely.

The prognosis depends almost entirely upon the nature or extent of the injury to the brain and also the nature of any operation that is undertaken and how soon it is done. Great depth of the coma, a temperature above 104°, and rapid advance of the symptoms are all signs of bad omen. Death, if it occurs, probably will do so in from two to ten days. In such a case of head injury the temperature chart is usually a valuable indication of the prognosis, for if the temperature remains persistently subnormal or markedly raised, the prognosis is bad: if it soon returns to the normal, the prognosis is good.

Laceration of the Brain. These injuries may be divided into two main classes, according to whether the laceration of the brain has occurred with or without a wound of the scalp and skull, connecting it with the exterior.

(*a*) *Without Penetrating Wounds.* The majority of cases of laceration of the brain seen in civil practice have no wound communicating with the exterior, and the condition is due to blows or falls; it may be associated with any form of fracture of the skull (see Chapter II.), though it is by no means uncommon to find serious cerebral injuries when the skull is intact. The injury to the brain may lie immediately under the point of the skull struck or at the opposite point or at both situations, while the types of pathological lesion found are described on p. 8. Soon after such an accident considerable œdema of the brain will set in, which may remain localised and soon pass off, but which in other cases spreads far and wide through the brain, giving rise to a marked general rise of intracranial tension. Degeneration and softening of large masses of brain substance may follow the more severe injuries, when the portion of tissue affected will become converted into a soft pulpy mass containing fat globules and known as "yellow softening." A large area of laceration probably will cause death, but smaller areas will heal and give rise to firm white scars in the brain, usually adherent to the meninges, which may be the cause of much trouble later on in life (see p. 26).

Clinical Signs. Such an injury is usually associated with a severe concussion, the symptoms of which pass directly into those of the cerebral laceration. In mild cases of laceration, when the concussion passes off, except for some rise of temperature for a few days and a very persistent headache, the patient may appear comparatively well. Under suitable treatment such a case will recover more or less completely, though rest must be prolonged, and it is quite possible that some impairment, mental or physical, will remain. In the more serious cases the concussion will pass directly into the conditions of cerebral irritation or cerebral compression within twenty-four hours, and if no "lucid interval" occurs it may be regarded as certain that a laceration of the brain with extensive subdural hæmorrhage is present. This will be confirmed by lumbar puncture. If a "lucid interval" is present the hæmorrhage is probably extradural (see p. 22). Every case of cerebral laceration is accompanied by some degree of **subdural hæmorrhage**, the blood spreading over the cortex in all directions, and it is to this hæmorrhage that many of the signs and symptoms are due. The bleeding may be severe enough rapidly to cause the well-marked signs of cerebral compression, while if the hæmorrhage increases comparatively slowly it will give rise in its progress to irritation of various portions of the cortex, which may be separated from each other and from the site of the laceration by considerable distances; in this way fits, twitchings, and spasms of various muscle groups will be caused, a corresponding paralysis setting in later. Hæmorrhage into and laceration of the cortex will give rise to either irritation or paralysis of the area concerned, so that the brain injury is largely responsible for any localising symptoms, while the extent of the bleeding and œdema are the features which give rise to the unconsciousness and general symptoms.

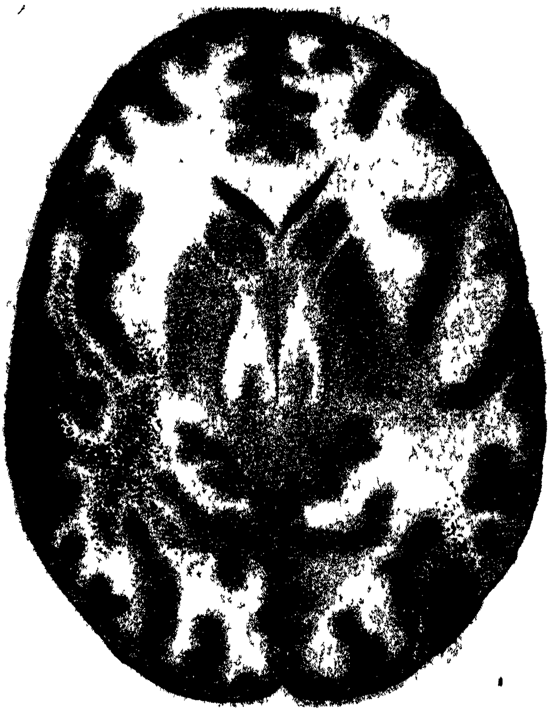

FIG. 3 Laceration of the brain at two opposite points A large hæmorrhage has also occurred on one side.

Thus it will be seen that many of the resulting neurological symptoms and signs will depend partly upon the irritation or compression of important centres by hæmorrhage and partly upon the areas of the brain injured.

(1) In the frontal lobes cerebral irritation and subsequent diminution of intellect probably will follow, especially on the left side, but there will be no motor or sensory symptoms.

(2) If the injury is in the neighbourhood of Broca's area in the third left

frontal convolution, motor aphasia probably will occur, a right-sided injury having a similar effect in left-handed people.

(3) If the motor area is involved there will be localised twitchings and convulsions, or paralyses of muscle groups on the opposite side of the body, according to the extent of the laceration, and these convulsions and paralyses may be seen sometimes to extend from one area to another. It must be remembered that similar paralyses will be caused by injuries of the deeper portions of the motor tract, such as the internal capsule or corona radiata, but in this case there may be no irritative effects.

(4) The motor centre for movements of the eyes may be irritated or paralysed by such an injury. In the former case there will be a conjugate deviation of both eyes to the opposite side, and in the latter case to the injured side.

(5) Deafness, loss of smell, and various forms of partial or complete blindness will be caused by lesions of the centres controlling these functions, but it is most unlikely that any of these physical signs will be capable of demonstration as the patient is probably unconscious.

(6) Lacerations of the cerebellum give rise to nystagmus, ataxia and vertigo, while the patient will fall towards the side of the injury.

(7) Injury to the deeper portions of the brain, such as the crus cerebri, the corona radiata and the pons will give rise to no spasms or convulsions, but only to the paralytic signs. Such injuries are usually rapidly fatal, and from their extent they are likely to involve both motor tracts, sensory tracts and various special senses. Paralysis of the various cranial nerves will also be common in the case of injuries in these situations. Lacerations of the medulla are invariably fatal.

For a complete discussion of the signs and symptoms associated with lesions of the various parts of the brain, the reader is referred to standard text-books on neurology, but it must be remembered that in the case of injuries the lesions are extensive and several different parts of the brain may be involved, that apart from actual lacerations, extravasations of blood are present both into the brain substance and in the form of free hæmorrhage flowing over the surface of the brain, and finally that the patient is probably deeply unconscious. So that any process of attempted localisation of an injury cannot have the accuracy which can be achieved in the case of cerebral tumours.

Many cases of severe cerebral laceration die within a few days. Some will recover perfectly, but nearly always there will be unpleasant persistent sequelæ, which will be described later. In this group of injuries, as there is no communicating external wound (unless a compound depressed fracture with laceration of the dura happens to be present), there is very little likelihood of the occurrence of infective complications with their grave results, such as frequently occur in the case of penetrating wounds.

Treatment. The treatment of a case of laceration of the brain has very largely been described already when dealing with the treatment of concussion, cerebral irritation and cerebral compression, while, as in all these conditions, appropriate treatment will have to be undertaken if any injury to the scalp or skull is present (see Chapter II.). If fits, convulsions or paralysis of muscle groups are seen early, they may form a guide as to where hæmorrhage is occurring, and when this is so, if the condition continues to advance and signs of cerebral compression set in, decompression will have to be undertaken at the spot indicated by the localising features with a view to arresting hæmorrhage and removing blood clot. If an approximate localisation of the injured portion of the brain is impossible, and decompression seems to be necessary on account of increasing convulsions or coma, the decompression should be performed over the injured area of the skull. When this is done there is always a possibility that the bulk of the hæmorrhage and pressure is on the opposite side as the result of a " contre-coup " injury—if, therefore, no signs of hæmorrhage or laceration are found and yet cerebral compression appears to be marked, there should be no hesitation in doing a further decompression on the other side. In not a few cases, where deepening coma is present, relief of pressure can be obtained in the absence of localising symptoms by an ordinary subtemporal decompression, usually best performed on the right side. It must be admitted, however, that the results of all these operations in cases of laceration of the brain are disappointing, and that the greater experience a surgeon has in dealing with head injuries the fewer cases he deems suitable for operation. A subtemporal decompression is also occasionally indicated in patients who have recovered from the concussion but remain irritable, semiconscious and, perhaps, noisy and restless (see Traumatic Œdema, p. 29). It is also sometimes valuable for certain of the sequelæ of head injuries, which will be described later (p. 26).

(*b*) *With Penetrating Wounds.* Open wounds of the brain are, of course, necessarily associated with compound fractures of the skull. They may result from blows or falls, but by far the most common variety is that associated with gunshot wounds. They will occur, therefore, at any part of the head. In the case of stabs, sword or axe wounds, oblique or valvular incisions will be found reaching through the scalp and bone and involving the brain underneath ; punctured wounds or stabs which may be caused by daggers, spikes, railings or other pointed instruments, such as knitting needles and umbrella ferrules, are more commonly seen where the skull is thinnest, *i.e.*, in such situations as the orbit, naso-pharynx or temporal fossæ. Gunshot wounds are particularly liable to lead to severe laceration of the brain substance, while pieces of bullet, bone, hair, clothing or other septic material are frequently carried far into the brain. When severe damage is done to the skull, so that a large opening results, it is often found that the general disturbance and the severity of the immediate symptoms are less than in the case of smaller punctured wounds, and concussion in these cases is often quite slight. Any of the forms of intracranial hæmorrhage (described on p. 21) may be associated with these injuries, but where the opening in the skull is large their symptoms are not likely to be marked as the blood can escape externally ; the signs and symptoms already described as being associated with cerebral laceration, concussion, cerebral irritation and compression usually will be present, together with various localising and focal symptoms dependent upon the parts of the brain injured. The most grave feature of these wounds and one which is almost peculiar to them is the prospect of subsequent infection, which, starting in the wound, frequently will involve the meninges and brain substance. The varieties of such an infection within the skull will be described later on p. 30, but we should note that when arising in connection with external wounds, infection is sometimes diffuse, in which case it may give rise to a diffuse septic meningitis or more commonly to a generalised meningo-encephalitis, either of which will prove fatal within a few days. In other cases the infection is localised by adhesions in the neighbourhood of the wound between the bone, the meninges and the brain, and when this is so a cerebral abscess may form within the brain matter, while a hernia cerebri is not uncommon. Cerebral abscess is especially liable to occur around any pieces of foreign matter that have been carried into the brain. In those cases which as a result of treatment have remained aseptic, the subsequent course resembles that of cases of cerebral laceration without a penetrating wound, though it must be remembered that, provided infection is avoided, the prognosis is rather better, inasmuch as the opening in the skull diminishes the likelihood of severe compression of the brain from hæmorrhage or œdema. The sequelæ of these injuries (see p. 26) are similar to those associated with other head injuries, with the special liability to the formation of adhesions between the brain and the meninges. Thus in these cases the dangers of cerebral compression, intracranial hæmorrhage or cerebral œdema are less, but those of intracranial infection are enormously increased.

Treatment. In all cases of a wound of the scalp and skull, which involves the brain, such as a compound fracture (see p. 70), a thorough exploration under an anæsthetic must be made as soon as possible, while an X-ray plate will be of the greatest value in showing the position of fragments of bone or foreign bodies. The wound in the scalp is excised and enlarged or a flap turned down, the skull opening enlarged by trephining or with bone forceps, and all loose or depressed fragments of bone removed. If the dura is intact it should not be opened unless signs of severe cerebral compression are present, but if it is wounded the track in the brain is explored gently and washed out with hot saline, while all fragments of bone, bullet or shell, clothing, etc., are carefully removed if within 2 inches of the surface. If deeper, they are best left in situ unless the track leads directly to them (Sargent). Disintegrated brain tissue should be wiped or washed away or removed by suction through a catheter (Cushing), while bleeding from the brain will be stopped by pressure with gauze swabs soaked in hot saline or by the application of small muscle grafts. The dura mater must then be sutured together or closed by means of a fascial graft, and the scalp opening is sutured in its turn completely, drainage being avoided. If infection occurs later the wound will need reopening in order to relieve tension, while acute meningitis or cerebral abscess must receive appropriate treatment (see p. 33). In such a case it must be remembered that symptoms may arise which are not due to the brain condition, but are the result of infection of the injured skull or scalp.

INTRACRANIAL HÆMORRHAGE

Mild degrees of hæmorrhage within the skull will occur in every case of bruising or laceration of the brain, but we are here concerned with the more extensive hæmorrhages which are the result of injuries to bigger arteries or veins. Such a hæmorrhage may be either outside or inside the dura mater, and its symptoms are closely allied to those of cerebral compression.

Extradural Hæmorrhage (middle meningeal hæmorrhage). Nearly every case of extradural hæmorrhage is due to injury to the middle meningeal artery, which enters the skull through the foramen spinosum and divides into two branches (see p. 6) to supply the meninges and skull. These branches are closely attached to the outer surface of the dura mater. In the lower part of its course the artery sometimes runs in a bony canal and is thus likely to be damaged by any fracture that occurs there. At the same time, cases of injury to the artery are occasionally seen in which the bone is not damaged, the dura mater having been detached from the skull by the violence and the artery remaining attached to the dura and thus getting torn. An injury to the middle meningeal artery is very uncommon. In most cases the anterior branch of the vessel is lacerated at the pterion, while in about 10 per cent. of cases it is the posterior branch which is damaged in the lower temporal region. The causative blow is usually sufficient to detach the dura from the skull to a certain extent, but the hæmorrhage accumulates rapidly between the bone and the dura, strips the dura off the bone further and forms a large extradural collection, burrowing downwards towards the base of the skull and pressing upon the side of the brain. If the skull is fractured at this point some of the blood will escape externally under the scalp, and in this way a certain amount of the compression may be relieved, a safety-valve hæmatoma being formed ; this is most common in children.

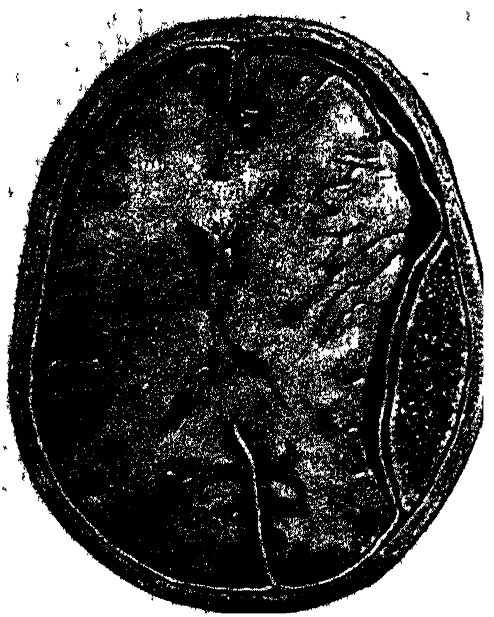

FIG. 4. Specimen of a skull and brain showing a middle meningeal hæmorrhage.

Clinical Features. This condition is naturally not uncommonly associated with other injuries, such as laceration of the brain or subdural hæmorrhage, by which its symptoms may be masked, but in a typical uncomplicated case, following an injury usually in the temporal region, due to a sharp blow from such an object as a cricket or golf ball, the symptoms are very definite. There is concussion for a short while ; this passes off, and the further symptoms of compression only supervene after an interval during which the patient is conscious and which is known as *"the lucid interval."* This lucid interval may last for any period from a few minutes to twenty - four hours, and during it the patient may be able to walk about or continue his work : it is of great value in distinguishing the condition from cerebral laceration or subdural hæmorrhage, as in these cases the coma and symptoms of compression will follow immediately upon the concussion. During this lucid interval the dura is being slowly stripped off the skull by the accumulating blood, and this is known as the second stage, before compression has set in. After a few hours the third stage sets in with vomiting and severe headache, and after a short period of restlessness and noisiness, the patient becomes drowsy and gradually comatose. The temperature falls to subnormal (rising a few hours later to 101° or 102°), the pulse becomes slow and full and the respiration rapid and stertorous, while, finally, all the symptoms of severe and general compression will be found. There is often a difference of one degree or more in the temperature of the two sides of the body, and this maybe quite an early sign. In the earlier stages, either during the lucid interval or while it is beginning to pass off, important localising signs will be present. If the anterior branch of the vessel is injured, the blood clot presses upon and irritates the cortical motor areas, and thus there will be twitching of the opposite side of the body, commencing at the face, spreading to the arm, and finally reaching the leg, and as the condition progresses and the pressure increases these twitchings will be followed by a paralysis of the same muscle groups, which spreads from one to the other in the same order, and gives rise finally to a complete hemiplegia. These twitchings and paralytic phenomena often supervene before the patient loses consciousness, while in the later stages they may spread actually to the opposite side and thereby complicate the diagnosis. In addition to this, important changes occur in the pupils, owing to the clot spreading to the base of the brain and pressing upon the third nerve on the side of the injury, so as first to irritate and then to paralyse it. These changes are as follows: On the same side as the injury the pupil first contracts, then resumes its normal size, and then becomes dilated and fixed, these changes occupying a few hours, while at a later stage, as the clot spreads, the pupil on the opposite side will go through similar changes, though its changes will lag behind those on the injured side by several hours. Ultimately a state will be reached in which both pupils are dilated and fixed, and when this is so the prognosis is very bad, while there may be great difficulty in settling which side the lesion is. In those cases where the posterior branch of the artery is injured, the bleeding is nearer the base of the skull, and the clot will then press sometimes upon the cavernous sinus, so as to give rise to proptosis, ophthalmoplegia and congestion of the eyeball and eyelid, while instead of the motor cortex being irritated, the pressure may fall upon the internal capsule and thus produce paralysis without preliminary twitchings. Inasmuch as most of these cases are accompanied by a fracture of the skull in the temporal region, if the fracture is simple, a large hæmatoma will form under the scalp in this situation, while if the fracture is compound blood will escape externally, so that the symptoms are not so likely to arise. If the opening in the skull is large this hæmatoma may actually pulsate, while pressure upon it may produce or increase the twitchings and fits. If there is a crack in the tegmen tympani or the external auditory meatus, there will be profuse bleeding from the ear, and such a prolonged and profuse hæmorrhage from the ear is always suggestive of an extradural hæmorrhage.

Rare cases will be seen in which hæmorrhage from the middle meningeal artery does not occur for some weeks after an injury, the injury at the time being thought to be slight and only perhaps accompanied by a small amount of concussion. This condition is known as "**late traumatic apoplexy,**" and when the hæmorrhage sets in it is accompanied by its most characteristic symptoms.

The diagnosis of this condition from an intra- or sub-dural hæmorrhage may not be easy. The latter condition spreads far more quickly, while the presence or absence of blood in the cerebrospinal fluid will be of great assistance. The two conditions are, however, frequently present together, and the frequency of this association with other cerebral injuries renders the prognosis of the condition very bad. Even with the best treatment available the mortality is over 60 per cent.

Treatment. The treatment consists in immediate operation to arrest the hæmorrhage and remove the compressing clot, and this is a matter of great urgency. Assistance as to the point at which the skull should be opened will be obtained by noting the symptoms and signs, and the trephine may in some instances be applied over that centre which appears to control the portion of the body which first became paralysed. The fracture in the skull will often indicate the best position for exploration, but in most cases a formal trephining is performed over the line of the middle meningeal artery (see p. 6). A scalp flap is turned down and a trephine circle removed, of about an inch in diameter. A mass of blood clot will be found under the bone, which is cleared out by the finger or by washing with saline and the bleeding artery looked for. It is usually lying on the dura, where it should be tied with a ligature on a thin curved needle. If it is lying in the bony canal the bleeding may be stopped either by crushing the bone in upon the canal, by plugging it with a small wooden peg, such as a sterile match, or by means of Horsley's aseptic bone wax. All blood clot is washed away and the scalp flap resutured. It is wise to leave a small drain in for forty-eight hours in case any further oozing should occur. It has been suggested that if the patient is seen in the early stages, and before coma is present, the hæmorrhage should be controlled by ligaturing the external carotid vessel in the neck, but we regard this as an uncertain and unscientific method.

Rupture of the internal carotid artery within the skull sometimes occurs in connection with a fractured base. In most cases death occurs very rapidly either from external hæmorrhage or from intense intracranial bleeding and cerebral compression. In a few instances, when the rupture is small and incomplete, an arteriovenous aneurysm forms in connection with the cavernous sinus (see Vol. I., Chapter X.).

Injuries of the Venous Sinuses. These are not uncommon, and though occasionally unaccompanied by a bony injury, they are more commonly due to fractures or penetrating wounds. The superior longitudinal sinus is that most often damaged, while injury to the lateral sinus and cavernous sinus is not uncommon. Occasionally a fragment of bone is driven into a sinus in such a way that bleeding does not occur until the fragment is removed. The blood pressure in these sinuses is so low that it is unlikely that any marked degree of extradural hæmorrhage will occur, and therefore unless the dura mater is torn no cerebral symptoms are likely to arise. When an external wound is present, the external hæmorrhage will be very severe and consists of a profuse flow of dark venous blood. More commonly the dura mater forming the inner wall of the sinus is damaged so that free bleeding beneath the dura can occur, and the blood may spread all over the surface of the cerebral hemisphere.

Sargent and Gordon Holmes have described a special train of symptoms associated with injuries of the superior longitudinal sinus, and due to the involvement by the hæmorrhage of the motor areas of both legs, which lie on either side of the sinus (see *British Medical Journal*, 1915). Infective sinus thrombosis, meningitis and pyæmia are liable to follow these injuries when an open wound is present.

Treatment. Venous hæmorrhage of this kind is controlled easily by plugging the sinus with gauze. Sometimes the wall of the sinus may be sutured, while in other cases a flap of fascia or muscle may be placed upon the bleeding point and this will control it. Ligature of a sinus is difficult and unsatisfactory, and plugging will be found far better. If signs of increasing compression of the brain are present trephining may be necessary, in which case the dura should be opened, the clot turned out and the bleeding point sought for.

Subdural Hæmorrhage. This has been referred to above and on p. 22, where it will be seen that it usually arises as a complication of laceration of the brain or of a wound of a venous sinus. The hæmorrhage may be (*a*) widely diffused over the cerebral hemispheres, or (*b*) localised to a comparatively small area; it always tends to gravitate to the base of the brain, while its symptoms are very variable and are largely those of the conditions to which it is secondary, such as contusion or laceration of the brain. Such a hæmorrhage is usually slowly absorbed if the patient recovers, but in some cases it will become encapsuled and give rise to a cyst, whose walls are composed of fibrous tissue, and which contains a brown-coloured serum. This condition is known as a **subdural hæmorrhagic cyst** and in the course of weeks or months will give rise to symptoms suggestive of cerebral tumour. Like laceration of the brain, a subdural hæmorrhage is often due to an injury by " contre coup."

In most cases of diffuse hæmorrhage the symptoms are simply those of general cerebral compression without any localising features, which comes on immediately after the concussion without any lucid interval. If the bleeding forms a localised subdural collection (subdural hæmatocele) the concussion passes off and the patient will partly recover ; but after some weeks of ill-health, either from further hæmorrhage or changes in the blood clot, increase of symptoms, with both localising signs and general compression, may set in, a condition very similar to the late traumatic apoplexy described on p. 23.

Treatment. The treatment is largely that of the conditions with which it is associated, while a lumbar puncture will be a useful aid to diagnosis. In cases where there are focal symptoms indicating a spot of greatest pressure, or if a lesion of the skull is present, operation for relief of pressure should be performed, but in many instances it is difficult to be certain where the chief hæmorrhage is, and even on which side it is, so that it may be difficult to decide where to operate ; if in any doubt, it is better to carry on with expectant treatment, unless the patient is obviously suffering from increasing general compression; this should always be relieved by a decompression. If operation is performed and the right locality has been selected, the dura mater will bulge into the wound when the skull is opened and be of a dark blue colour. It is carefully opened, the blood clot removed, and any bleeding points which are discovered tied ; if, in the presence of definite symptoms, no hæmorrhage is found, the other side must be opened at once. A subdural hæmorrhagic cyst which is causing symptoms should be removed on the lines of a cerebral tumour (see p. 49).

Cerebral Hæmorrhage in the Newly-born. During the process of birth, especially in first-born children, where the labour has been prolonged or the presentation abnormal, a subdural hæmorrhage sometimes occurs. This is probably due to the moulding and overlapping of the bones of the skull, which causes tearing of the veins passing from the cortex to the superior longitudinal sinus. Marked asphyxia during birth also may play a part in its production. Such an extravasation of blood, therefore, will be found chiefly in the neighbourhood of the superior longitudinal sinus near the motor cortex and often on both sides. There is usually no evidence of injury to the scalp or skull, but it is difficult to induce the child to breathe ; the fontanelle will be tense and the child dull, still and sleepy : often asphyxia is marked when it is born. After a few days it will be noticed that one or other limb is paralysed, either an arm or a leg or not uncommonly both legs, though these paralyses are often overlooked for a surprisingly long time. In the course of a few weeks the paralysed limbs may become rigid, while convulsions will occur and ocular palsies may be discovered. If lumbar puncture is performed in the early stages, there will be increase of tension and the fluid will be blood stained. If neglected, this condition will lead to grave, permanent damage, mental deficiency, Jacksonian epilepsy, blindness, or Little's disease (spastic paralysis of one or more limbs), being common.

Treatment. The increased intracranial tension may be relieved for the first few days by daily lumbar puncture and withdrawal of 5 to 10 c.c. of fluid, but if the diagnosis is certain the serious after-effects will be avoided best by turning down an osteoplastic flap consisting of the soft parietal bone and removing the blood clot. This operation may be necessary on both sides and should be done, if possible, within the first two or three weeks of life. During its performance the greatest possible care must be taken to prevent shock and hæmorrhage.

SEQUELÆ OF HEAD INJURIES

Any injury causing cerebral symptoms is serious, so that the possibility of distant and long lasting sequelæ must always be borne in mind, and the patient warned that long rest and medical supervision are essential. Sclerosis of areas of the brain, white or red softening in patches and adhesions between the brain, the dura mater, and the skull or scalp, often will be found, and these may give rise to a variety of symptoms, depending on their situation. Of cases of serious head injury, about 25 per cent. are totally incapacitated permanently from work and only about 40 per cent. are capable of undertaking their normal full work again.

In many cases affections of sight or hearing or of the other cranial nerves are found to persist, while in other instances severe headaches, giddiness, and fits are complained of in addition to the conditions described below.

Most of these more physical conditions are dependent upon definite changes in the brain, the membranes or the bones. Depressed fragments of bone, scarred, thickened and adherent meninges, which may be adherent to both scalp, skull and brain, cystic collections within the meninges, subdural cysts (arachnoid cysts), which may be the remains of hæmorrhages or may be the result of chronic inflammatory processes following the injury, loss of or scarring of brain tissue, œdema and degeneration of the nerve elements, are all conditions which, if present, may account for persistent sequelæ. Many of these conditions are avoidable if prompt and efficient operative treatment is applied soon after the injury ; while the fact that they are so often the cause of persistent later symptoms makes the possibility of improvement in the sequelæ as the result of an exploration well worth considering.

Traumatic neurasthenia is a not infrequent sequel to even a minor head injury ; here the patient's mental attitude, character and disposition may be greatly changed, so that he loses the power of concentration, suffers from insomnia, headache, tremor and various "phobias," cannot work, or says he cannot, and becomes dirty, immoral, irritable and nervous.

In order to avoid the symptoms due to these conditions and relieve them when present, he should lead a quiet and regular life, avoiding alcohol, a hot climate, and excessive diet or sexual excitement. Anything which might lead to cerebral congestion or overstrain must be particularly avoided, and fatigue, badly ventilated rooms and excitements of all kinds are specially harmful. There is no objection to light work provided overstrain is avoided, and possibly after a year or two of this easy life he may return gradually to normal conditions.

No form of operative treatment will be of benefit here. In addition to the above form of neurasthenia, definite traumatic hysteria is sometimes seen which occurs in people of a bad family history, after an injury and may (see Railway spine, p. 102) be accompanied by any of the usual signs and stigmata of hysteria (see p. 12).

Traumatic Epilepsy. This is a condition in which as the result of injury, either to the skull, the meninges, the brain, or all three, convulsive attacks of the Jacksonian type occur. The causative conditions may be a rough projection of bone inside the skull following a fracture, a painful scar in the scalp, chronic thickening of the skull, adhesions between the meninges and the brain anchoring the brain tissue, a scar or hæmorrhagic cyst (see p. 25) in the brain itself, chronic meningitis, or the presence of a foreign body. Such cases are often associated with large gaps in the skull which have occurred as the result of gunshot wounds or operations performed for their relief, but the probability is that in such a case the fits are in no way due to the gap in the skull but are the results of the anchoring adhesions between the brain and the dura, and the dura and the scalp or bone. Many cases of Jacksonian fits are nontraumatic and due to tumours or abscess in the brain.

The symptoms of a traumatic epilepsy are convulsive seizures of what is known as the Jacksonian type. These fits begin in a particular group of muscles, the first group affected always being the same in the same case and depending upon the situation of the brain lesion. From this group the convulsions or twitchings spread to other muscle groups, whose cortical representation is close by, till finally many of the muscles in the body will be involved, and unconsciousness usually supervenes. The attacks begin suddenly, usually with an aura or " signal symptom," such as jerking of the thumb or twitching of other muscles. Sometimes these warning signs are ocular and take the form of conjugate deviation or subjective phenomena such as bright flashes of light. In other cases they are auditory, in which case they will take the form of strange noises in the ears. The nature of the warning sign usually refers to a definite cortical area in which it appears to arise, and this is very valuable as indicating the site of the lesion. These attacks sometimes begin soon after the injury, and in other cases not for many years. At first they only occur at long intervals, but they tend to become more and more frequent till finally there are several in a day ; in the later stages degenerative changes occur in the brain similar to those in idiopathic epilepsy, so that some muscle groups may become permanently paralysed, or the patient become an imbecile or pass into the " status epilepticus." In this last condition fits succeed one another rapidly, so that the patient remains unconscious, the pulse, temperature and respiration rise and he dies in coma. As the cortical discharge which causes the convulsions overflows into neighbouring centres, consciousness is generally lost before many muscle groups are involved, and always before muscle groups on both sides of the body are affected. After the convulsions are over the muscle groups involved may remain in a tonic spasm for a short time.

A careful distinction must be made between true Jacksonian epilepsy and an ordinary idiopathic epilepsy which appears to commence some time after an injury. The most important distinguishing feature is the way in which the fits of the former disease commence in one area and spread, often without loss of consciousness in the early stages, in a definite march.

Treatment. The administration of bromides or luminal often will render the fits less severe and less frequent, but such treatment is only palliative and likely to fail in the end. The alternative treatment is operation, but this must be undertaken only in those cases in which the convulsions remain localised to a considerable degree and do not spread to the opposite side of the body. Moreover, no operation can be performed unless the warning or " signal symptom" is such as to indicate that the lesion lies over an accessible portion of the brain, or where definite evidence in the form of a scar in the scalp, a depression in the bone, or a persistent fixed headache indicates its locality. The prognosis of the operation is much better if the injury is recent, for diffuse degenerative changes are not then likely to have occurred.

The operation consists in opening the skull at the site of the lesion as indicated by any of the features described above. Any cause which is found which might irritate the cerebral cortex is removed. Depressed fragments of bone, a subdural cyst, or a foreign body are easily dealt with, but in many cases nothing will be found except a scar in the brain tissue, which is usually adherent to the dura mater. These scars have been removed with a small portion of surrounding brain substance, but in most cases the fits have returned after an interval of freedom, and this proceeding is not recommended. In the cases due to gunshot wounds, in which there is a large opening in the skull and a scar in the brain beneath it adherent to the dura, which in its turn is adherent to the scalp, it is probable that the symptoms are due to the anchoring of the brain by these adhesions. Acting on this assumption Sargent advocated the introduction of two celluloid plates to close the gap in the skull and to free the brain. A scalp flap is turned down, the dura mater is set free from the bone for some distance from the margins of the bony opening without being itself opened, a thin plate of celluloid is introduced between the skull and the dura and a thicker celluloid plate outside between the skull and the scalp. Celluloid having no tendency to form adhesions to surrounding tissues, in this way the brain and attached dura are permitted freedom of movement. This method gives results which are better than the older methods, where the scars were excised and layers of fat or fascia, or of sterilised gold or silver foil, were introduced. Permanent cure of Jacksonian fits is not common after any of these operations, but their frequency is usually greatly diminished, and they are rendered much less severe. The locality of the injury probably has an influence upon the prognosis, and the prognosis is better when the lesion is in the motor area than when it is in the sensory, frontal or special sense areas. Even with a properly performed operation the prognosis is not good, and if the epilepsy has been going on for more than two years cure is unlikely. Prevention in this condition is much better than cure, and every effort must be made by means of properly designed operative treatment at the time of the injury to prevent bony depressions, adherent scars, etc., from occurring and causing epileptic symptoms.

Traumatic Insanity. Insanity of various types following head injuries is not uncommon. It is not an insanity of any special variety, nor does it follow any particular type of injury, any special locality of injury, or at any definite interval after the injury. It is far more likely to occur in patients with a family history of insanity or other nervous troubles, while physical signs in the nervous system, or sequelæ of the injury in the form of traumatic epilepsy or depressed fractures, are not often present. Cases which come on within a few days of the injury are often only temporary, and these frequently will recover within a few months, but the prognosis of the later cases is as bad as in any other form of insanity. If physical signs pointing to any definite lesion are present, either in the nervous system or on the skull, an exploratory operation is justifiable and has in some cases been followed by excellent results; otherwise there is no treatment.

Traumatic Cephalalgia. Persistent headache, either general or more commonly localised to the site of the injury, is a common after-effect. It is usually constant and aggravated by exertion, alcohol, heat, or excitement. The localised types have almost always a local cause in the form of scarring, thickened meninges, or the formation of a subdural cyst. In these an exploration is the proper treatment; in the more diffused type, if general remedies fail, a subtemporal decompression may be beneficial.

Post-traumatic Œdema. Cases occasionally will be seen in which after a head injury followed by concussion, which passes off soon, the patient persists for several weeks in a drowsy and irritable state. It is more often seen in children, who may lie in an apathetic condition, not unconscious, but not quite realising where they are. Headache and absence of reflexes, with occasional fits, will occur, but there is no definite localising symptom, and the condition does not fall quite in line with either concussion, cerebral irritation or cerebral compression. It is certainly not progressive, but at the same time exhibits very little tendency to spontaneous cure. The pathology is unknown, as it is not as a rule fatal, but it is highly probable that the condition is due to either a local or generalised œdema of the brain and its membranes, fluid being present in the subdural space.

Treatment. Every effort must be made to diminish the intracranial tension by repeated lumbar puncture, purging, bleeding, and leeches on the scalp. Hypertonic saline will be of use (see p. 13). If the symptoms persist in spite of this treatment the skull must be opened over the seat of the injury, if it can be identified, or otherwise in the temporal region.

The complications of head injuries which are due to infection are meningitis, encephalitis, sinus thrombosis, cerebral abscess, and hernia cerebri. These will be considered on pp. 30, 34, 36 and 52.

DISEASES OF THE MENINGES AND BRAIN

The commonest and most acute forms of intracranial disease are due to inflammations of various kinds. All intracranial inflammations are almost always bacterial in origin, and these may be divided into three main groups of meningitis, brain abscess, and infective thrombo-phlebitis of venous sinuses. The organisms which are most commonly present in lesions within the skull are the streptococcus, staphylococcus aureus, pneumococcus, Bacillus coli, Bacillus pyocyaneus, the meningococcus, and the gonococcus. Tuberculous and syphilitic infections are also common. These forms of intracranial inflammation are almost invariably secondary to other lesions, of which the commonest are :—

(*a*) Compound fractures of the skull or other septic wounds on the head, especially gunshot wounds and those where the dura is torn;

(*b*) Middle ear disease, which is the most frequent cause of all, so much so that middle ear disease must be suspected in every case of intracranial infection. Such a middle ear infection is usually associated with inflammation of the mastoid antrum (see p. 327), the organisms reaching the interior of the skull, either via the blood in the emissary veins, along the sheaths of the facial or auditory nerves, or as a result of destruction of the bone in the neighbourhood of the tegmen tympani or the groove in which the lateral sinus runs.

(*c*) Infection of the nose and its accessory air sinuses, erysipelas, carbuncles, or other infections of the scalp, lips or face are not uncommon causes.

(*d*) Similar processes occur in pyæmia, septicæmia, and other general infections, and especially in connection with chronic infective lesions in the lungs, such as bronchiectasis, chronic lung abscess, or chronic empyema.

(*e*) Tuberculous lesions and the acute form of meningitis due to the meningococcus, and known as cerebrospinal meningitis, are only of medical interest.

The various forms of intracranial inflammation may closely resemble each other in the symptoms to which they give rise, while it is by no means uncommon for more than one of them to be present in the same patient.

MENINGITIS

Two main varieties of meningitis are recognised, (1) Pachymeningitis, where only the dura is involved, and in practice this means that it is only the outer surface of the dura which is affected, and (2) Leptomeningitis, where the infection is inside the dura and the arachnoid and pia mater are both involved. Of these, the latter is by far the more serious and the more common condition.

Pachymeningitis. This usually results from the spread of infection from a neighbouring lesion of the bone, such as is seen in a septic compound fracture, in involvement of the bone in gummatous ulceration of the scalp, in erosion of the tegmen tympani or the wall of the sigmoid fossa in chronic middle ear suppuration, or in association with septic osteitis of the frontal bone caused by disease of the frontal sinus. It very rarely occurs as a result of simple contusion of the skull without an external wound, the infection then being blood-borne. The portion of the dura involved becomes red, vascular and thickened, and covered on its outer surface with granulation tissue, while there will be a small collection of fluid between it and the bone. This resulting thickening of the dura is protective in character, but in spite of this the infection will sometimes spread to the inside of the dura and give rise to a localised or diffuse leptomeningitis. The symptoms of pachymeningitis of this kind are slight, a mild rise of temperature and pulse rate from the infection and a certain amount of localised headache being all that is noticed.

Extradural (Subcranial) Abscess. In many cases, as the result of the above condition, suppuration will occur between the dura and the bone and give rise to this form of abscess; so that the condition may be due to any of the causes of pachymeningitis mentioned above, but it is especially common in association with compound fractures and with middle ear disease. Any form of septic osteomyelitis of the skull is likely to lead to it. Such an abscess gives rise to very severe headache referred to the site of the abscess, sudden rise of temperature with malaise, toxæmia and shivering. An initial rigor may occur, but there will be no regular rigors. The abscess is not usually big enough, lying as it does outside the dura, to cause any marked rise of intracranial tension, so that coma, slowness of the pulse, or cerebral vomiting are not likely to occur; nor are focal or localising symptoms in the central nervous system, unless the abscess is over the motor area and is very large. A serous meningeal effusion without actual infection is often associated with it. In addition to these signs and symptoms, if there is no open wound in the scalp at the site of the abscess, the scalp over it develops a hard, puffy, tender, local swelling due to œdema. This is characteristic of an extradural abscess, and is known as **Pott's Puffy Tumour,** having been first described by Percival Pott in 1760.

The extradural abscesses associated with compound fractures of the skull do not sometimes appear for several weeks, and they may then slowly grow to a large size, sufficient to cause cerebral compression and even to produce focal symptoms. There being an open wound in the scalp, Pott's puffy tumour is not likely to be seen in association with this variety. The margins of such a wound will look unhealthy, while at the bottom of it bare, necrosed bone will often be seen.

Optic neuritis is sometimes seen in extradural abscess. This is possibly due to rise of intracranial tension, but more likely the result of the pus spreading to the base of the skull. The prognosis in the case of an extradural abscess due to a compound fracture is considerably worse than that of one due to ear disease, while the symptoms of acute osteitis of the skull (see p. 84) are likely to be present also. The symptoms of the disease, when it follows upon aural suppuration, are usually less marked (see p. 327).

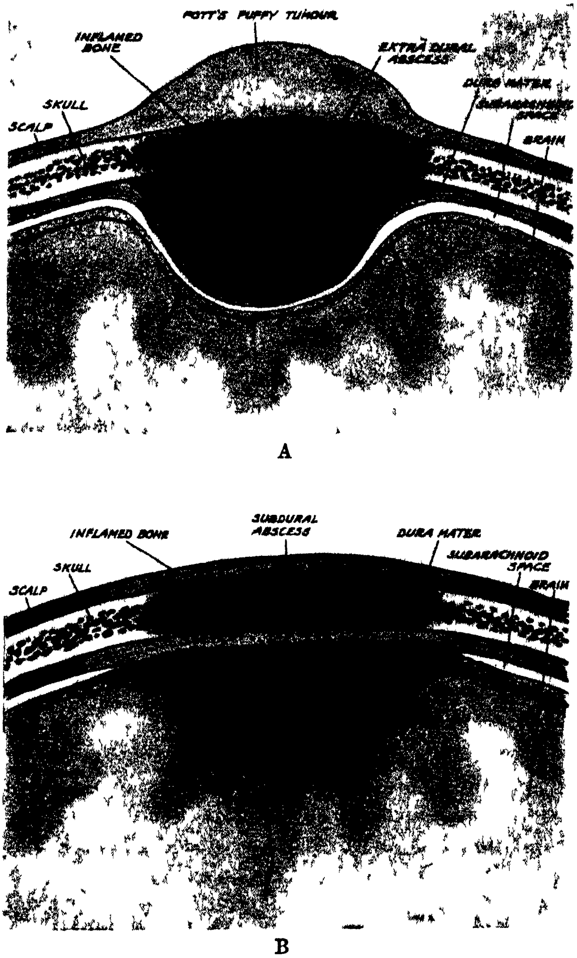

FIG. 5. Diagrammatic representations of (A) Extradural abscess with Pott's puffy tumour. (B) Subdural abscess.

Treatment. This will depend upon the cause of the abscess. In principle, it will consist of opening and draining the abscess by removal of the bone over it.

When the condition is due to middle ear or mastoid disease, the abscess will lie either in the middle fossa of the skull over the tegmen tympani or in the sigmoid groove around the lateral sinus, this being by far the commonest situation. The mastoid antrum and air cells must then be opened, the eroded bone in one or other situation followed up, freely cut away and a sufficient opening made to provide drainage. When due to a compound fracture of the skull the scalp wound must be enlarged, and loose, depressed and inflamed portions of bone removed, either with the forceps or after a preliminary trephining. Further bone is then cut away with skull forceps over the whole area where the dura has been detached from the skull. In other cases a trephine circle will have to be removed at the site where the scalp œdema is most marked, and all carious and infected bone cut away until the limits of the abscess are reached. Great care must be taken not to damage the dura, which will be inflamed and softened. The cutting away of this carious bone may need to be very extensive and leave large gaps in the skull, but if the patient survives, no trouble need be expected from this (see p. 26).

Acute Leptomeningitis (Acute Septic Meningitis). This arises from exactly the same causes as do the foregoing conditions, but it must be remembered that, though it is much more likely to supervene if the dura mater is torn or injured, nevertheless, leptomeningitis often will occur, especially in middle ear disease, when the dura mater is quite intact, infection having spread through to the inside of the membrane from the outside. Apart from local lesions in the scalp and skull, the condition is also seen as the result of metastatic or pyæmic infection in general septicæmic conditions, pneumonia, typhoid or chronic suppurative lung diseases. In a few cases adhesions will form and shut off the infected area from the general subdural space. Suppuration will then occur there and a localised subdural abscess be formed, while the infection may spread to the superficial layers of the cortex, and give rise to what may be termed a meningo-encephalitis. The symptoms of such a localised leptomeningitis are similar to those of an extradural abscess, except that a Pott's puffy tumour is not likely to form, that they tend to be more severe, and that there will probably be local irritative or paralytic focal signs, depending on the area of cortex involved. The treatment will be the same as that of an extradural abscess.

More commonly, however, the infection is generalised and the whole subdural space is quickly invaded, the superficial layers of the brain being also involved, with the result that a general septic meningitis sets in and the infection spreads rapidly in the loose subdural tissues both over the cerebral hemispheres and down towards the base of the brain. The membranes become congested and reddened, the vessels become engorged, and a profuse effusion of cerebrospinal fluid occurs both throughout the subdural space and into the ventricles. This is at first serous, but rapidly becomes purulent, so that a thin layer of thick pus is formed all over the surface of the brain, the cerebrospinal fluid throughout the spinal canal also becoming thick and turbid, and containing organisms. The surfaces of the convolutions are flattened, œdematous and matted together, while small punctate hæmorrhages may be found in the brain matter ; the dura mater and the skull tend to become unduly adherent to each other.

Clinical Features. The first and most marked symptom is a violent headache, which may be generalised, frontal, occipital, or confined to the locality where the causative lesion is. The head is hot, the face flushed, the pulse thin and quick, and the temperature rises suddenly, with possibly one rigor, and remains between 103° and 105°. There is at first a period of excitement and irritation of the brain, as shown by delirium, photophobia, irritability and twitchings of the muscles, this being especially marked in children, who become restless, and at intervals utter a peculiarly piercing cry. Vomiting of the cerebral type, which occurs without nausea and independently of food, is common and persistent, constipation is marked, while the localised twitchings and spasms of the muscles increase ; in a short time the period of depression sets in, the patient gradually becoming comatose, while the pulse changes from being rapid and thin into a full and bounding one. Respiration becomes slow and stertorous, and death is almost certain to occur within five days. A lumbar puncture always should be performed : it is the earliest means of making the diagnosis and relieves some of the symptoms ; the tension will be found to be increased, while the fluid is turbid and contains leucocytes and the infecting organisms, a state of affairs which is not present in a cerebral abscess. A leucocytosis is present in the blood.

When a hernia cerebri is present (see p. 52), as is not uncommon in the presence of a septic compound fracture, the condition is often less acute, and it may last for several weeks before death ensues.

These general symptoms are present whether the cerebral hemispheres or the base of the brain are chiefly involved. When the inflammation is chiefly over the hemispheres, convulsions, twitchings and spasms of muscle groups are more marked, while they may be followed by paralyses of various kinds. The abdominal reflexes disappear early, while the knee-jerks are at first brisk, but finally disappear also.

If the meningitis is chiefly basal the temperature is higher, squinting will be present, while retraction of the head and neck and Kernig's sign are marked. The pupils ultimately will become dilated and fixed, and severe optic neuritis will be present. Any of the cranial nerves are liable to be irritated or paralysed in this case, so that in addition to eye changes there may be trismus, facial paralysis, torticollis and tâche cérébrale, while fine fibrillary twitchings of the face and mouth are very characteristic. This variety of the disease may resemble tetanus closely.

Treatment. When the condition is due to a local source of infection in the skull or scalp this must be dealt with and removed as soon as possible, and the call for operative interference is very urgent. Thus middle ear suppuration, mastoid disease and frontal sinus disease will require appropriate treatment (see Chapter VII.), and compound fractures will be explored. All these operations should aim, when meningitis is present, at opening the subdural space and draining it, though the intricate character of this space and its subdivision and localisation by adhesions, deposits of lymph and swelling of the brain matter render attempts at drainage very inefficient. Chemotherapy by administration of suitable sulphanilamide drugs should be carried out in all cases, and some surgeons even recommend irrigation with sulphanilamide solution *via* an opening in the skull large enough to admit a lumbar puncture needle. Large doses of urotropin, repeated lumbar puncture, leeching, ice-bags or Leiters' tubes will be found useful, while the patient must be kept absolutely quiet in a dark room on a bland diet and his bowels and urinary functions attended to. The prognosis is very bad indeed, very few cases of recovery having been recorded.

A subacute form of meningitis, known as **serous meningitis**, is sometimes seen in association with middle ear disease and will be described in Chapter VII., while chronic forms of leptomeningitis leading to infiltration and thickening of the membranes, with adhesions to the cerebral cortex, are also seen. These follow injuries, and are associated with cerebral tumours and syphilitic disease.

Cerebrospinal meningitis, either sporadic or epidemic, tuberculous meningitis, which is chiefly basal, and syphilitic meningitis are of purely medical interest; for a description of these conditions standard text-books on medicine must be consulted.

THROMBOPHLEBITIS OF THE VENOUS SINUSES

An infective thrombophlebitis of the intracranial venous sinuses is by no means uncommon, either the lateral sinus, the superior longitudinal or the cavernous sinus being affected. Though these conditions occasionally follow injuries of the scalp or skull, it is most common for them to arise as the result of suppuration of the skull bones from other causes. The commonest form of this disease, thrombosis of the lateral sinus, is almost exclusively caused by acute osteitis of the mastoid bone in connection with middle ear suppuration, while in the case of a cavernous sinus thrombosis the primary cause is often a cellulitis of the scalp, suppuration in the nose or in the sphenoidal sinus or erysipelas, carbuncles, boils and other septic lesions on the face, lips and neck. The organisms reach these blood spaces either through the wall of the sinus by direct continuity (as is the case in the lateral sinus), or by a thrombosis extending up a vein which leads to the sinus, this method of infection usually occurring in the superior longitudinal and cavernous sinuses. The resulting changes in the sinus are those of an infective thrombophlebitis, described in Vol. I., Ch. X.; the infected clot within the blocked sinus rapidly softens and becomes disintegrated, so that general pyæmic infection of the whole body occurs rapidly, as a result of pus or portions of infected clot being carried away in the general circulation and being deposited as infected emboli in any part of the body, especially the lungs, liver, and spleen. In addition to this, infection sometimes will spread backwards along tributary veins (owing to the blood stream therein being reversed as a result of the blocking of the sinus by the thrombosis), and thus cerebral or cerebellar abscess, meningitis and caries of neighbouring bones also will occur as consequences.

It is probable that the smaller venous sinuses are also liable to thrombophlebitis, but they do not give rise to any diagnosable features.

Clinical Features. These will depend largely upon which sinus is affected, but in all cases there will be first of all the presence of a causative lesion with its signs and symptoms,. a more or less sudden onset of severe headache, restlessness and irritability, and regular rigors, occurring every day or every second day, during which the temperature rises rapidly to 103° or 105°, after which it comes equally rapidly to the normal with the accompaniment of a profuse perspiration. The pulse is rapid and small, while vomiting and loss of appetite are marked. Towards the end the patient becomes dull or even comatose, while symptoms of other intracranial infections may be seen; it is not uncommon for meningitis, cerebral or cerebellar abscess and slow spreading of the thrombosis from one sinus to another to occur and end the scene

Lateral Sinus Thrombosis. This is the commonest form. It is invariably due to middle ear disease and is more common in young people, the infection spreading into the sinus either directly from the mastoid bone or along the veins that enter into the sinus from the petrous bone. In a patient who is previously known to have either a chronic middle ear suppuration or more commonly acute mastoid disease, there is sudden onset of increased pain and general headache with a sudden rise of temperature for a few days: after two or three days the regular rigors already described set in, the temperature oscillating violently up and down. The discharge from the ear lessens or disappears, while the general features mentioned above all become marked. Œdema over the mastoid process increases and there may be congestion of the scalp veins in that neighbourhood, while not infrequently there will be photophobia and optic neuritis. The thrombosis usually extends down the jugular vein, and when this is so a firm, tender cord will be felt in the upper part of the neck down the course of the vein, and the duskiness and congestion of the face and scalp will then increase. The cervical lymphatic glands will become tender and enlarged, while in advanced cases suppuration will occur outside the vein in the neck. In other instances abscesses will be found in the face, infection having spread there up the common facial vein. After this condition, with its repeated rigors and high temperatures, has continued for a few days or a week, signs due to pyæmic lesions elsewhere will be noticed. Pain in the chest with dyspnœa, cough, foul sputum and signs of consolidation, point to abscess or gangrene of the lung, while diarrhœa and abdominal distension, with jaundice, a more continuous type of pyrexia, enlargement of the spleen and possibly a septic rash, indicate a more or less general septicæmia with abdominal involvement. (When this occurs the condition may superficially resemble typhoid.) As long as other forms of intracranial infection do not supervene, the patient's mind often will remain clear and his general condition fairly good for a week or two, but if signs of meningitis or cerebral abscess supervene, he will soon become comatose and death ensue. The prognosis depends upon the extent of the general infection: if adequate and early surgical treatment is undertaken in such cases 60 per cent. of patients should recover.

It must be remembered that a tender swelling in the neck is not necessarily conclusive, as it may be due to Von Bezold's type of mastoid abscess (see p. 328) or to inflamed glands.

Treatment. As this condition invariably originates from the ear a mastoid operation on the usual lines (see p. 329) is first performed that the source of infection may be removed. The bone is then cut away backwards to expose the sinus, which will be found surrounded by pus and granulation tissue. If in doubt whether it is thrombosed or not it may be punctured by a fine hollow needle. When thrombosis is present the jugular vein should be tied below the lowest point of the clot by an incision down the side of the neck, the sternomastoid being drawn backward. This will prevent any further emboli escaping into the general circulation, and it is an advantage at the same time to ligature the common facial vein to prevent infection spreading up that way. This is all that some surgeons consider necessary; others, however, advise that the lateral sinus should then be opened and a plug pushed up into its upper end to prevent any infection spreading in that direction: the jugular vein is then opened above the ligature, so that the thrombus can be scraped or washed away and the cavity packed with gauze, which will control any bleeding; or the jugular vein may be tied between two ligatures, cut, and its upper end brought out into the skin wound. Any other intracranial infection is dealt with at the same time and the operation completed on the lines described on p. 329.

Cavernous Sinus Thrombosis. Here the source of infection is most commonly a carbuncle or other infective lesion in the soft tissues of the face, neck, lip or orbit, and the condition, though usually commencing on one side, soon becomes bilateral. A small pustule or boil is more likely to cause this than a large septic wound, because there is probably greater tension in the tissues. The same general signs and symptoms are present as above, though the onset of pyæmia is less rapid and the patient frequently dies before its symptoms have arisen. Frontal headache is often the first sign, and marked interference with vision will set in early. Drowsiness is marked, but often there are no rigors or vomiting. The pyrexia varies from 100° to 107°. Proptosis or chemosis is definite evidence that a sinus thrombosis is present, while an actual orbital cellulitis occurs sooner or later. Marked exophthalmos will be present with congestion of the orbit and eyelids, the latter usually becoming œdematous, whilst ptosis, squint and ophthalmoplegia will occur as the result of the orbital nerves becoming paralysed, especially the sixth nerve. The cerebrospinal fluid is under increased pressure and is often opalescent: its sugar content is diminished. Meningitis is always a terminal event, the condition rapidly proving fatal. There is really no treatment, though attempts have been made to drain the sinus through the sphenoidal sinus.

Superior Longitudinal Sinus Thrombosis is rare. When it occurs it is due to pyogenic lesions of the skull or scalp, while it sometimes occurs spontaneously in young women suffering from chlorosis. In addition to the usual general symptoms, œdema and congestion of the scalp, epistaxis and certain neurological signs similar to those described on p. 25 will be seen. These take the form of cortical anæsthesia of the legs, and loss of power of both legs, which is more marked in their distal segments and is accompanied by an extensor plantar reflex, ankle clonus and briskness of the knee jerks. In addition there may be tenderness along the line of the sinus and small abscesses may form in the scalp at the site of emissary veins.

The treatment of thrombosis of this sinus is unsatisfactory, and though attempts have been made to ligature the sinus by opening the skull, little success has followed.

ABSCESS OF THE BRAIN

An abscess in the brain may be the result of several different processes.

1. By far the most common cause of a cerebral or cerebellar abscess is chronic middle ear suppuration, and when this is so the abscess usually occurs either in the temporal lobe or the cerebellum. In this case the infecting organisms reach the brain matter, either by direct spread, in cases where the bone is eroded down to the dura, or else they are carried there by the veins or the lymphatic vessels. Such an abscess usually occurs in the white matter of the brain and is often single, while it is most commonly found in that portion of the cerebellum or temporosphenoidal lobe which is nearest to the middle ear. It often will be accompanied by an extradural or subdural abscess. Similar abscesses will be found in connection with frontal sinus suppuration, osteomyelitis of the frontal bone or sphenoidal or ethmoidal disease, and in these cases they are most common in the anterior portion of the frontal lobe.

Such an abscess varies greatly in its acuteness and rapidity of formation; it is usually of a subacute nature and is surrounded by a capsule of firm, fibrous tissue which in its turn is surrounded by condensed brain tissue, this being especially the case in otitic abscesses; and when this is so the abscess may remain latent and cause no symptoms for many weeks, though at any time acute symptoms may set in as a result of spreading œdema or rupture into the ventricle. If the process is more acute and rapid the capsule is not so marked, and the surrounding brain is engorged and infiltrated, being in a state of spreading encephalitis. The arachnoid and pia mater over an abscess are usually milky and œdematous, while the pus is often foul, of a brown or green colour, and contains sloughing portions of brain matter; very often it is sterile to ordinary cultural methods.

2. Other cases of cerebral abscess are the result of injuries, especially of infected compound fractures of the skull, when they may be seen either within a few days of the injury, lying superficially in the grey matter (they are in this case usually accompanied by a leptomeningitis), or later on deep abscesses may form in the white matter. They are especially common in gunshot wounds, and are then due to the carrying into the brain substance of an infected foreign body or fragment of bone. In many cases of this kind the localisation of the infection is very incomplete, and the surrounding brain tissue becomes infected so as to lead to a condition of diffuse spreading encephalitis.

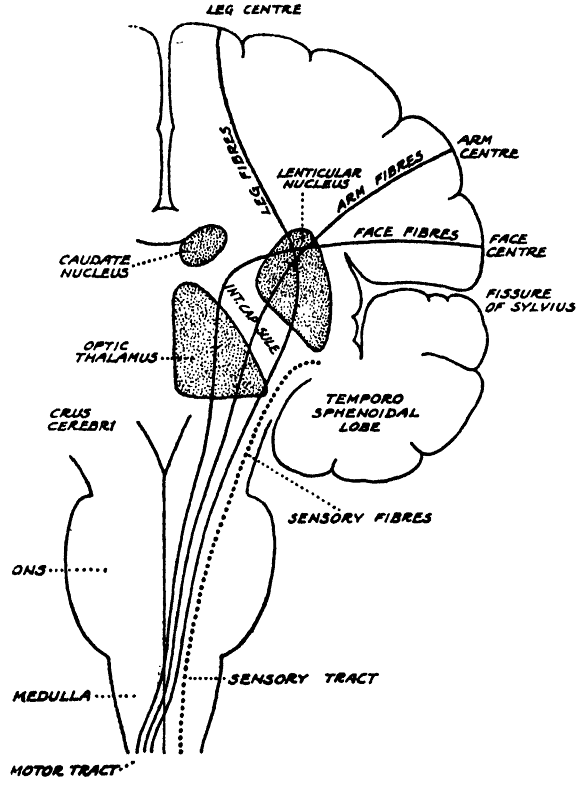

FIG. 6. Diagram showing the way in which an abscess in the temporosphenoidal lobe affects the motor and sensory tracts.

Abscesses in the brain have occasionally been described as a result of simple contusions of the head, in which case the infection must have been brought by the blood stream, while in gunshot wounds it is not uncommon to find the abscess appearing many weeks after the injury and at some part of the brain apparently remote from the track of the wound. These abscesses associated with injuries are often very chronic and latent, and are especially found in the parietal and frontal lobes.

3. Acute osteitis of the skull bones, apart from suppuration in the nasal sinuses or middle ear, is responsible for a certain number of cases of intracranial abscess.

4. Pyæmic or metastatic abscesses of the brain are not infrequent, general pyæmia or septicæmia, scarlet fever, typhoid and other general conditions sometimes giving rise to them, while bronchiectasis, chronic empyema and other chronic septic conditions of the lungs are not infrequently the cause of this condition. In these cases the abscess is usually single, and is then amenable to surgical treatment, but multiple abscesses are occasionally seen. Chronic abscesses due to the breaking down of gummata or tuberculomata will be met with at times.

Clinical Features. These will depend largely upon the cause of the abscess, its situation, and whether it is of an acute or chronic type. In many cases its onset will be masked by the signs and symptoms of the causative lesion or by an accompanying encephalitis or meningitis (especially in those due to injuries of the skull), while in the chronic cases the patient may complain of nothing except continuous dull headache, until suddenly, after some weeks, the temperature rises to 103° or 105° F., and he becomes comatose and dies within a day or two. This is usually due to the abscess rupturing into the ventricles or subdural space. In the commoner, subacute form of the disease, such as is associated with middle ear suppuration, three well-marked stages may be described.

(*a*) In the initial stage, lasting two or three days, there is a severe headache, which may be roughly localised to the site of the abscess, and is accompanied by a considerable rise of temperature and by one or two irregular rigors. The pulse rate is raised, vomiting is present, the tongue is dirty and constipation is marked, while if the abscess is due to middle ear disease the otorrhœa will diminish or cease.

(*b*) As the later or fully-developed stage of a localised abscess sets in the patient's mental condition changes and he gradually becomes dull, stupid and apathetic. He is not unconscious, but torpid, with a slow cerebration, answering questions slowly and after an interval, but usually correctly. The headache is usually less, but tenderness may be present over the abscess. The shivering disappears, the temperature falls to subnormal, unless septic lesions are present in the skull or scalp, the respiration becomes slow, the vomiting, constipation and dirty tongue more marked, and the pulse becomes slow (40 to 60), full and bounding, while the patient rapidly emaciates, and becomes anæmic and pale. The face becomes dull, heavy and expressionless, and gradually localising or focal symptoms, depending upon the situation of the abscess (see p. 39), will set in. In addition to this, optic neuritis, more marked on the side of the abscess, general muscular weakness (apart from definite paralysis), diminution of the reflexes and leucocytosis will be present. Lumbar puncture yields a fluid which is under increased tension, which may be clear or murky, but which does not contain organisms unless meningitis is also present.

(*c*) As the condition progresses the final or terminal stage sets in, in which the vomiting increases and the patient becomes comatose and death ensues. The temperature and pulse rate will remain down until the end unless the abscess bursts into the ventricles, in which case a rapid rise of temperature to 103° or 105° F., a rapid and irregular pulse with Cheyne Stokes' respiration, dilated pupils, lividity of the face and diffuse muscular twitchings and contractions all over the body, will set in suddenly and death will ensue within a few hours. If the pus bursts into the subdural space the symptoms of a rapidly-spreading meningitis will be caused (see p. 32), which will be fatal in a day or two.

Localising Features. Assistance in settling the locality of the abscess may be obtained by considering its cause. Abscesses due to injuries of the skull and gunshot wounds are probably either near to the skull injury, or to the track of the missile, or in the neighbourhood of foreign bodies or bone fragments as shown by an X-ray film. Those due to diseases of the nasal sinuses or frontal bone are usually in the frontal lobe, while if due to chronic middle ear suppuration, the abscess is probably in the temporosphenoidal lobe or the cerebellum on the same side as the diseased ear. Chronic abscesses of the brain are occasionally visible in an X-ray film.

A **temporosphenoidal abscess,** if small, may cause no focal symptoms, but if large it will give rise to pressure, either on the motor cortex or upon the internal capsule, with corresponding paralytic symptoms on the opposite side of the body. Though the paralysis produced may be preceded by twitchings of the muscles concerned, these twitchings are more common in meningitis, and, in any case, this stage is not likely to be observed. Great attention must be paid to the order in which the muscle groups on the opposite side of the body are paralysed ; thus if the face is first affected and then the arm and leg successively, the paralysis is due to pressure upon the cortical centres on the opposite side of the brain, while if the paralysis spreads in the opposite direction, from the leg to the arm and then the face, and especially if sensory changes are present also, the pressure is upon the internal capsule and the abscess is deeper (see Fig. 6). It must not be forgotten that it is quite possible that facial paralysis will be present already on the same side as the ear disease as the result of direct involvement of the facial nerve in its intra-petrous course. If the abscess is large certain cranial nerves will be affected, especially the third, and in this case there will be ptosis, external deviation, and a fixed dilated pupil on the side of the abscess. When the abscess is on the left side pressure upon the inferior frontal convolution may cause motor aphasia, and upon the back part of the superior temporal convolution auditory aphasia, but here again it must be remembered that if middle ear suppuration is present there will be also probably deafness on the diseased side.

An *abscess in the frontal lobe* often gives rise to no localising features, but if it is on the left side, motor aphasia or apraxia (loss of the power of initiating co-ordinated movements) may be present (see p. 47).

In the occipital lobe an abscess is nearly always of pyæmic origin, and here there will be interference with the eyesight.

Rare cases have occurred in which spontaneous evacuation of an abscess has taken place—through the cribriform plate in the case of a frontal abscess, and through the ear in a temporal abscess.

Cerebellar Abscess. This is a common form of brain abscess, and is usually in the lateral lobe of the cerebellum. It is nearly always the result of chronic middle ear disease, in which case it is often associated with a thrombosed lateral sinus or extradural abscess close by. When small the signs and symptoms of this type of abscess will be very indefinite, but as it increases, the amount of pressure-compensation that can occur beneath the tentorium being small, serious and diagnostic features come on rapidly. The general symptoms of cerebral compression and cerebral abscess referred to on pp. 13-38 are especially noticeable when the abscess is beneath the tentorium, and vomiting, subnormal temperature, slow pulse, optic neuritis, delayed cerebration or unconsciousness set in rapidly and are marked. In addition to this there will be vertigo, with difficulty in co-ordinating movements, staggering and reeling from side to side, and a tendency to fall, usually towards the same side as the abscess, while nystagmus will be present. Trismus, deviation of the eyes to the opposite side, skew deviation of the eyes, and retraction of the head and neck are sometimes seen, with yawning and gaping, while the limbs on the side of the lesion will often appear weak or hypotonic without actually being paralysed (paresis), and they may later become spastic ; the knee jerks and other deep reflexes are nearly always increased, the plantar reflex normal. Respiration is particularly affected, being irregular, feeble and frequently of the Cheyne Stokes' type ; total respiratory failure frequently occurs (especially during anæsthesia), while the heart-beat continues strongly.

Differential Diagnosis. Meningitis and cerebral abscess may resemble each other closely, but in the former condition high temperature, irritability, excitement, rapidity and irregularity of the pulse, rigidity and twitchings of muscles and lack of any definite focal signs contrast with the slow pulse, dull mental state and localising evidence in the latter condition. Meningitis comes on much more rapidly and progresses more quickly than does cerebral abscess, while all such physical signs as reflex changes, muscular paralyses and optic neuritis are bilateral.

A chronic cerebral abscess and a cerebral tumour usually will resemble one another closely (see p. 45). The latter condition, however, comes on more slowly and affects the temperature and general bodily metabolism less, causing less marked loss of weight and anæmia.

The previous history often will help to differentiate the two conditions, as in the case of an abscess there is almost certain to be a cause for the infection. Optic neuritis is more marked in tumour, while the cellular and chemical contents of the cerebrospinal fluid also may serve to distinguish the two conditions. There usually will be a characteristic leucocytosis in cerebral abscess. In some cases where coma is coming on, the suspicion of uræmia or diabetes will be raised, but these diseases can be excluded as the result of urinary examination.

Treatment. This consists in operation as soon as the abscess is localised and may be extremely urgent in some cases. When, as is most commonly the case, the abscess is secondary to chronic middle ear suppuration, the operation will commence with an exploration of the mastoid antrum and air cells as described on p. 326, and during this part of the operation an indication will probably be found as to where the abscess is. If the abscess is in the temporosphenoidal region, the pus will be found tracking from the antrum up in that direction and possibly the tegmen tympani will be eroded. Part of the squamous portion of the temporal bone and of the tegmen tympani will then be cut away forwards and upwards with forceps, and the dura freely exposed in this situation ; bulging and lack of pulsation of the dura will indicate that the abscess is close underneath, and the dura can then be opened and a pair of sinus forceps gently introduced into the brain so that the abscess is opened and the pus let out. Drainage with a large rubber tube or celluloid drain will then be required. Some surgeons advocate that when the mastoid antrum and cells have been opened and drained, the cerebral abscess should be approached and dealt with by a trephine opening situated over the abscess and through a separate skin incision.

Similarly, if the abscess is in the cerebellum, the bone will be cut backwards behind the lateral sinus, the dura exposed and opened and the pus evacuated. Some surgeons prefer to open the cerebellum in front and to the inner side of the lateral sinus through the inner wall of the mastoid antrum. Sloughing brain matter is often present in the abscess cavity and should be washed out or sucked out. A small gauze plug is packed round the tube for twenty-four hours to encourage the formation of adhesions to protect the subdural space from infection and the scalp flap loosely sutured into place ; the tube should be left till it gradually falls out.

In other cases not due to middle ear disease a large scalp flap will be turned down over the abscess and the skull opened by one of the methods described on p. 88, the cutting of a bone flap being unsuitable in this case as drainage will probably be required. The dura is opened, and the brain explored with a director or pair of sinus forceps. If the abscess is recent, acute and with soft walls, it is opened and drained as already described, but if old-standing with hard, thick walls, before it is opened into, an attempt should be made to shell the whole abscess with its capsule out and to remove it completely without opening it (see Cerebral Tumour, p. 48). In those cases which are due to a septic compound fracture, the abscess can nearly always be opened by exploring and enlarging the original wound, removing bony fragments until an intact and uninjured dura mater is exposed all round the wound ; the abscess is then explored and drainage established in that way.

In these operations the anæsthetic of choice is the administration of ether by the intratracheal method, as this obviates any risk of respiratory failure.

The after-treatment consists in administration of sulphanilamide or urotropin, careful dressing and attention to the bladder ; a rough guide as to when the tube should be removed is given by noting when the discharge becomes serous. In all head operations morphia is to be avoided as far as possible as it may produce respiratory failure ; this is especially so in cerebellar cases.

Intracranial Syphilis. Syphilis is responsible for many chronic intracranial conditions. Chronic syphilitic meningitis is not infrequent and is usually secondary to syphilitic caries of the skull or to a gumma in the brain close by. It leads to a chronic thickening of the meninges, which does not in itself cause any symptoms. In other cases a diffuse, syphilitic, gummatous meningitis is found (especially in congenital cases), which is most marked at the base of the brain and leads to a thickening and adherence of the membranes there which may give rise to such conditions as hydrocephalus (see p. 42), and very commonly to paralyses of various cranial nerves from pressure upon them where they pass through the dura.

Localised gummata are common in the brain and they give rise to the symptoms of cerebral tumour (see p. 44). A characteristic feature of these intracranial syphilitic lesions is a marked spontaneous variation in the severity of their symptoms ; so common are they that they must be considered as a possibility in any chronic intracranial lesion. The diagnosis will be clinched by the Wassermann reaction, and when it is positive the treatment is that of syphilis in general (see Vol. I., Ch. VI.).

Intracranial Tuberculosis. Localised tuberculomata are not uncommon in the brain in patients with a tuberculous focus elsewhere in the body. They are usually multiple, vary in size from a pea to a hen's egg, and form round, fibrous, encapsulated tumours containing caseous or calcareous material.

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They are especially seen in the basal portions of the brain, such as the cerebellum and pons, and in young persons. In their vicinity the meninges are adherent to the brain and may be thickened and covered with miliary tubercles, unless, as is unusual, the nodule is deep within the brain substance. Their clinical features are entirely those of other forms of cerebral tumour (see p. 44), while they can be diagnosed only when evidence of tuberculosis elsewhere in the body is present. When met with at operation they should never be removed, as the patient probably will die of tuberculous meningitis if they are interfered with, usually after two or three months.

Tuberculous meningitis is common in children. It is usually regarded as a medical condition, and for its description standard works on medicine must be consulted. Many surgical measures have been tried for its relief, but lumbar puncture is the only one which has met with any success.

HYDROCEPHALUS

Hydrocephalus is the condition where an excess of cerebrospinal fluid is present. If this excess of fluid is within the ventricles, the condition is known as *internal hydrocephalus;* if outside the brain, in the subdural space, as *external hydrocephalus.* An acute form of hydrocephalus has been described, but this is simply an excess of fluid both inside and outside the brain in association with various types of meningeal infection, while chronic external hydrocephalus is rare and is due to chronic meningitis or cerebral tumour.

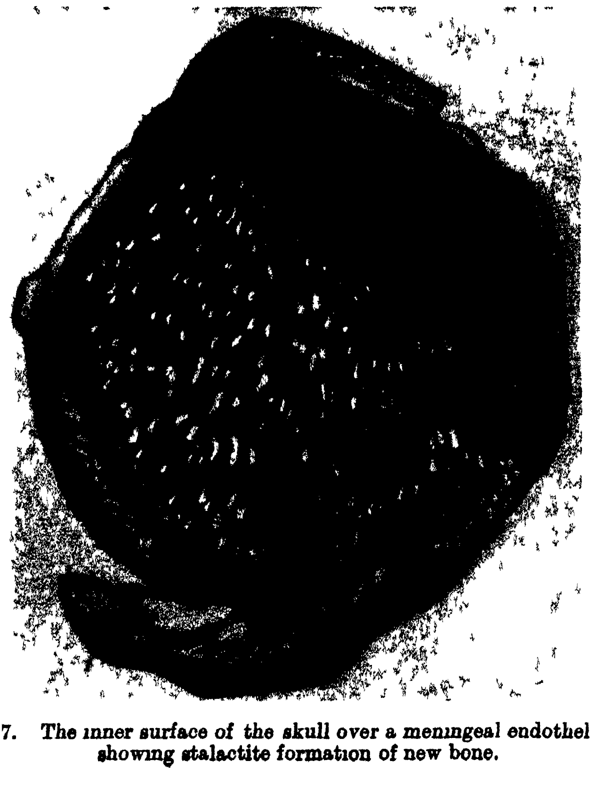

FIG. 7. The inner surface of the skull over a meningeal endothelioma, showing stalactite formation of new bone.

Chronic Internal Hydrocephalus is common in children. The excess of fluid in the ventricles in some cases is probably due to excessive secretion by the choroid plexus or ventricular ependyma as a result of chronic inflammation, but more commonly it is due to an obstruction either to the outflow of blood through the veins of Galen or else at the foramina of Majendie and Key and Retzius, so that the cerebrospinal fluid cannot escape through the ventricles into the subdural space. Such an obstruction may be due to a congenital deformity, or to early rickets, but is most commonly the result of chronic inflammation of the meninges at the base of the brain, which is often syphilitic and occasionally tuberculous. Pressure upon the inferior longitudinal sinus will also give rise to it; thus it will be seen that in some cases the condition is congenital; in other cases it is acquired in very early life, while often it will be seen in adults as the result of the pressure of a tumour, usually in the posterior fossa.

In all cases there is a distension of the lateral ventricles with fluid, and this reacts upon the bones of the skull so that in children the head swells, the skull bones separate from each other and become atrophied and thinned and the fontanelles become large, tense, bulging, and may cease to pulsate. The brain is pressed upon and thinned out, in some cases sufficiently to be incompatible with life, while in other instances fluctuation may be obtained and the skull bones will crackle under pressure. The scalp is thinned, the skin glossy and shiny, with big blue veins and the hair scanty. The child thus has an enormous vault to its skull with a small wizened, aged-looking face, the eyes protruding because of the pressure on the orbital plates. It cannot lift its head or move it, is fretful and continually crying, is almost always blind or mentally deficient, while vomiting, wasting, tâche cérébrale, incontinence, optic neuritis and fits frequently will be present: any of the cranial nerves may be paralysed by pressure. The outlook is very bad, as in most cases the condition progresses and death results within a year or two; many children with it are born dead. An occasional recovery will be seen in rickety or syphilitic cases.

The condition is very frequently accompanied by some form of cephalocele or spina bifida, and may follow operations for the relief of the latter.

Treatment. It must be remembered that this condition is, in many cases, merely a symptom of some other underlying cause, and it is at this cause that treatment must be primarily directed. Thus rickets and syphilis should be looked for and treated appropriately. Many ingenious methods of surgical treatment have been devised for the treatment of this complaint with remarkably little success, partly because operation offers no prospect of success unless it is undertaken very early before the brain is permanently damaged. The following procedures have been adopted :—

(*a*) Tapping of the lateral ventricles with a hollow needle, which is introduced at the lateral angle of the anterior fontanelle, one ounce of fluid being withdrawn once a week for several weeks. This has frequently produced improvement, very seldom a cure. Lumbar puncture may be tried also, but is not often effective.

(*b*) Drainage of the fourth ventricle through an opening made in its roof, or canalisation of the iter by this approach (see Fraser, *British Journal of Surgery*, vol. x, page 165).

(*c*) Removal of the choroid plexus to diminish the secretion (Sargent).

(*d*) Establishment of a permanent communication between the ventricles and subdural space, so that the fluid may flow out in the normal way. This can be done by the insertion of a silver or platinum tube, strands of silk or decalcified bone tubes, but in most cases the benefit is only temporary. In other cases efforts have been made by similar procedures to drain the ventricles into the subcutaneous tissues or into the extradural space; again only with temporary benefit.

(*e*) Attempts have been made to drain the subdural space of the spinal canal into either the peritoneal cavity or the retroperitoneal tissues by trephining the body of one of the lumbar vertebræ, though it is not obvious how this can be expected to benefit an internal hydrocephalus.

(*f*) In congenital cases the foramina through which the fluid should escape are usually not blocked and may be larger than normal, and thus here no form of ventricular drainage is likely to be successful. In these cases Stiles has recommended ligature of the internal carotid first on one side, and some weeks later on the other side, in order to control the amount of cerebrospinal secretion. In addition to this the subdural space has been drained into the superior longitudinal sinus, the jugular vein and even into the peritoneum by a long tube or strands of silk passing down under the skin of the neck and chest.

CEREBRAL TUMOURS

Any portion of the brain is liable to be the seat of a new growth. Several different forms of tumour (including new growths, cysts, gummata and tuberculomata) are found there, while it is an unfortunate fact that the majority of them are malignant. These tumours sometimes will commence in the brain tissue, while in other instances their seat of origin will lie in the membranes, the cranial nerves, or the skull bones, and they will involve the brain secondarily. Thus the varieties of tumours met with in this situation are:—

(1) *Sarcomata* and *osteomata* of the skull, hydatid cysts, hæmorrhagic and post-traumatic subdural cysts (see p. 24), and, closely resembling these, chronic abscesses.

(2) *Gliomata.* These are usually seen in comparatively young patients and are small, round-celled new growths resembling neuroglia in structure. The rate of growth is very variable, and the tumour may be found in any part of the brain; it is always continuous with the brain tissue, having very little capsule, while it exhibits marked powers of infiltration and may be almost indistinguishable from the surrounding brain tissue except by its feel; it is always locally malignant. Hæmorrhages are liable to occur into this tumour and lead to sudden increase in symptoms (see p. 45).

(3) *Primary Sarcomata.* These may occur at any age, and though malignant they are slower and more likely to be encapsuled than gliomata. Secondary sarcoma, teratoma and carcinoma are also common.

(4) *Endotheliomata.* These are common tumours, which grow from the arachnoid: they are well-defined and encapsulated and do not infiltrate the brain, simply pressing upon it and displacing it. They often grow to a large size and may undergo the peculiar changes characteristic of a *psammoma* (see p. 45). They are not malignant and are the most favourable form of brain tumours the surgeon can encounter.

(5) *Fibromata.* These are usually seen growing from the sheath of the vestibular part of the auditory nerve in the posterior fossa of the skull, and are known as "lateral recess" or "cerebello-pontine angle" tumours (see p. 47). They are a soft and exceedingly cellular form of fibroma, but not malignant. They are prone to degenerate into cysts, especially after operative

interference. Complete operative removal is often possible by displacing the cerebellum to one side.

(6) *Tuberculomata.* These are more common in young patients with tuberculosis elsewhere in the body. They are most common in the cerebellum, are often multiple, and their rate of growth varies from time to time.

(7) *Gummata:* usually seen in adults over forty. These grow rapidly and are frequently multiple, usually being found on the surface of the brain and sometimes in the dura mater. They are not necessarily accompanied by a positive Wassermann, nor do they always respond rapidly to anti-syphilitic treatment.

(8) *Psammomata.* These are a peculiar form of endothelioma (some authorities regard them as fibrosarcoma), which occur in the meninges, pineal body or choroid plexuses. They consist of spindle-shaped cells which may develop into fibrous tissue and become arranged in whorls almost like cell nests. The central portions of these whorls undergo degeneration and calcification, so that hard, concentric granules of calcareous material are formed. Hence these growths are sometimes called " sand tumours."

(9) *Hæmangiomata.* These are not rare, and are especially seen over the motor area or in the cortex of the cerebellum. Some previous injury seems to be the cause in some instances. At times they are multiple and are accompanied by retinal hæmangiomata, hypernephromata of the kidney or cystic disease of the kidney or pancreas (**Lindau's disease**), their walls having only the thinnest possible lining membrane; thus removal is difficult, though it should be attempted.

Unfortunately many cerebral tumours occur in the deeper parts of the brain where they cannot be approached surgically.

All these tumours are usually surrounded by an area of brain which may be sclerosed or softened; while, if they are superficial, the membranes will be adherent or thickened; in many cases the inside of the skull will be roughened and spiky immediately over them and the bone itself be thickened for some distance round (see Fig. 7).

Recently a new classification of cerebral tumours has been attempted by certain American authorities.

(1) The endotheliomata have been renamed *meningiomata*—a name which means very little and gives no suggestion as to their pathology. They are thought to arise from the groups of meningocytes around the arachnoid villi. They are usually seen close to the venous sinuses, grow slowly and push the brain aside. Trauma appears to be a predisposing cause.

(2) The *gliomata* have been divided histologically into fourteen different varieties, of very greatly varying malignancy. The more important of these fourteen different varieties are:—

(*a*) *Medulloblastomata,* which are by far the most malignant and rapidly break through the pia mater.

(*b*) *Spongioblastomata*—also very malignant and corresponding to the older " gliosarcoma."

(*c*) *Astrocytomata.*

(*d*) *Oligodendrogliomata,* both of which are very much less malignant and which have a far more favourable prognosis after operation.

Clinical Features. These consist of two main groups, namely (A) localising features, which depend upon the situation and nature of the tumour, and (B) general symptoms, which are due to the rise of intracranial pressure it produces, these general symptoms always supervening sooner or later with a rapidity and severity dependent also upon the nature and site of the tumour. In most cases, however, the general symptoms must be regarded as late symptoms, and except in the case of tumours occurring in or near silent areas, when focal signs will be absent, it will be found usually that the localising features appear first before the general symptoms are detectable.

(A) *The focal or localising signs* may be difficult to detect at first, but it is in this comparatively early stage that the tumour should be brought under treatment if possible, if the patient is to have any reasonable chance of permanent cure by operation. It cannot be too strongly insisted upon, therefore, that a complete examination of the nervous system must be made, by a skilled neurologist, if necessary, and that the suspicion of a cerebral tumour should be considered in every case where a definite organic lesion of the brain appears to be present. The early symptoms consist in some localised alteration in the cerebral function, and this will depend upon where the tumour is.

(*a*) If *the Rolandic or motor area* is involved attacks of Jacksonian epilepsy will be the first thing noticed. Here fits occur, starting, after a definite aura, by the twitching of certain muscle groups on the opposite side of the body, these muscle twitchings gradually spreading to other groups in the neighbourhood in an orderly sequence, and consciousness ultimately being lost (see p. 27). As such a tumour increases in size these phenomena, due to irritation of the centres, disappear and become replaced by a paralysis of the muscle groups concerned, which is accompanied by brisk reflexes, usually an extensor plantar reflex and marked spasticity ; this paralysis often takes the form of a localised monoplegia, while later on sensory changes will occur and motor or sensory aphasia may set in in the case of left-sided tumours. It must be remembered that these changes are chiefly suggestive of lesions in or pressing upon the cortex and that subcortical lesions give rise to paralytic phenomena often without the preceding irritative fits. Thus, if the tumour lies beneath the cortex and involves the centrum ovale or internal capsule, there will be a more marked motor paralysis of the spastic type and without Jacksonian fits, while sensation will be lost on the paralysed side of the body, and if the tumour is large there will be a complete spastic hemiplegia with hemianæsthesia and hemianopia. Tenderness on percussion of the skull over the

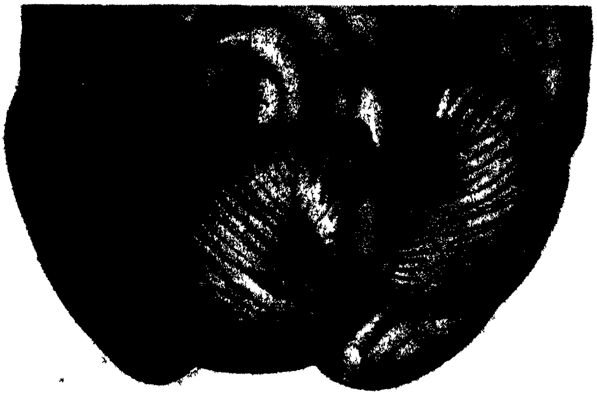

FIG. 8. The base of the brain showing a tumour of the right eighth nerve (lateral recess tumour). (After specimen in University College Hospital Museum.)

site of the tumour is sometimes found to occur in cortical lesions, but not in subcortical ones, while it must be remembered that in many cases, at any rate after the very earliest stages have passed, both cortical and subcortical parts of the brain will be involved. As any tumour increases in size certain cranial nerves may become pressed upon and either irritated or paralysed.

(*b*) If *the post-central or sensory area* is the starting point of the tumour, there will be tingling and alterations in sensation; but as the tumour grows forwards the motor area will again become involved and similar fits to the above will occur, often preceded by sensory auræ.

(*c*) If *the marginal and angular gyri* are involved there will be word blindness, while if the growth extends more deeply into the brain the optic radiation will be compressed, and this will give rise to an homonymous hemianopia, as will also be the case if one occipital lobe is involved.

(*d*) *Tumours in the cerebellum* are common, and they give rise to symptoms similar to those of cerebellar abscess (see p. 39), where vertigo, nystagmus and interference with co-ordination are present. The patient tends to fall towards the side of the lesion. There will be paresis with increased reflexes of the muscles on the side of the tumour, which sometimes will be of a spastic type. In addition, there may be marked yawning, retraction of the head and rigidity of the muscles of the neck.

(*e*) *Tumours in the cerebello-pontine angle* are not uncommon (acoustic or eighth nerve tumours), and are usually fibromata growing from the sheath of the auditory nerve, close to the internal meatus; they are occasionally bilateral. At times an endothelioma of the meninges occurs here and gives rise to similar clinical features. Here the symptoms of cerebellar tumour will be present and in addition certain features due to localised lesions of some of the cranial nerves on the side of the tumour. Thus the seventh and eighth nerves are most commonly affected, giving rise to facial paralysis, giddiness, tinnitus and marked nerve deafness, which is usually preceded by loss of power of perceiving high-pitched notes, while in addition any of the other cranial nerves from the third to the eleventh may be irritated or paralysed, all these cranial nerve phenomena occurring on the side of the lesion. Later, pressure upon the pons will produce a spastic hemiplegia of the opposite side, and the pushing down of the cerebellum into the foramen magnum will lead sometimes to sudden death (especially after lumbar puncture), due to involvement of the vital centres in the medulla by pressure on the foramen magnum.

(*f*) *Tumours in the anterior part of the frontal lobe* give rise to very few focal signs; there may be a loss of smell and taste and often there are vague mental changes, the patient being unable to concentrate and becoming dirty and immoral; he often will be drowsy and pass into curious dreamy states at intervals. Sometimes he is suspicious and at other times unduly elated; other cases have been noticed to be frequently scratching their nose, while in most instances they become insane in time. As the tumour grows and passes backwards, motor signs and symptoms will be caused.

(*g*) *Tumours of the Pineal Body.* These are rare. From the position of the tumour it may be expected to produce an obstructive hydrocephalus and pressure on the corpora quadrigemina. Headache, giddiness and papillœdema occur early, and later ptosis, limitation of upward movements of the eyes and disappearance of the pupillary reaction to light. Later there may be loss of hearing from involvement of the inferior corpora quadrigemina. In a few cases these tumours have been removed by retracting the posterior half of the right hemisphere outwards from above to expose the splenium and then incising this structure, under which the pineal body lies.

(B) *The general symptoms* consist of severe intermittent headache, often worst in the morning, which is very severe and occurs in paroxysms, is localised to part of the head and is increased by coughing, lowering the head, or raising the blood pressure. Any headache which frequently appears on first waking in the morning, even though it soon passes off, is always suspicious of an increase of intracranial pressure. There may be tenderness, and the pain may be most marked at the site of the tumour. Optic neuritis, with choked discs and papillœdema, is present and ultimately leads to optic atrophy, while the neuritis will be most marked on the side of the tumour, is especially marked in the case of temporosphenoidal and subtentorial tumours, and often leads to marked limitation of the field of vision for blue. Such an optic neuritis is in no sense inflammatory, but is entirely due to increased cerebrospinal tension forcing the cerebrospinal fluid into the sheath of the optic nerve, and interfering with the circulation. The vision at first will be little affected, but as the condition persists and atrophy sets in, partial or total blindness will follow quickly. Vomiting is often present; it is of the "cerebral" type, usually occurs in the morning, and is very characteristic, as it bears no relation to food and is unattended by nausea; it is present in about 50 per cent. of cases and is most marked in subtentorial tumours. Mental changes, irritability and slow cerebration are often noticeable. Constipation is marked, but in early cases the pulse and temperature are little affected; as the case progresses all the general features increase; the patient wastes, becomes drowsy and apathetic with a subnormal temperature and very slow, full, hard pulse; he gradually becomes more and more stuporous, passes into coma and dies. Towards the end the temperature, previously subnormal, sometimes will run up rapidly to 104° or 105°, while the breathing is stertorous and of the Cheyne Stokes' type. The severity and rapidity of the symptoms will depend largely upon the rate of growth of the tumour, while at any moment a sudden and marked increase of symptoms may occur as a result of hæmorrhage into the neoplasm, especially in the case of a soft glioma.

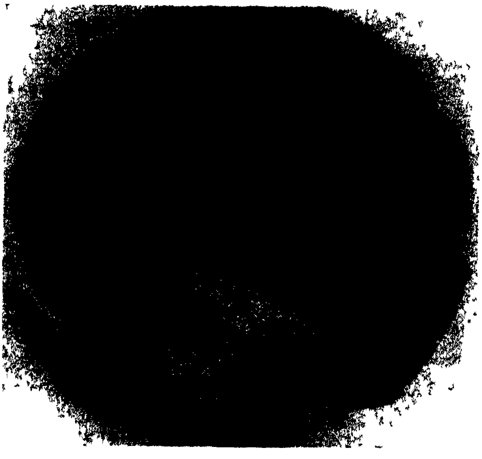

FIG. 9. Ventriculogram showing distension of the ventricles with air.

Ventriculography. This is a method sometimes of use in the diagnosis of cerebral tumours, especially those at the back and base of the brain. It consists in demonstrating changes in the size and shape of the ventricles by taking an X-ray photograph of the skull after air has been introduced into the ventricles. The air is introduced either by lumbar puncture or better by tapping the ventricle (see p. 8).

The *prognosis* is grave in all forms of tumour of the brain; the majority of them are malignant, and many of them are deeply placed and liable to involve the vital centres. Syphilitic gummata are the most favourable type, for antisyphilitic treatment will usually produce improvement, but recurrence even here is common and permanent structural changes in the brain are usually left, which will lead to persistence of symptoms.

Treatment. In every case the possibility of the lesion being gummatous should be remembered, a Wassermann test (both of the cerebrospinal fluid and blood) be performed, and a course of salvarsan and iodide of potassium should be administered for a short period to see if improvement can be obtained by this means. If this fails or in cases which do not appear to be syphilitic, the question of operation will have to be seriously considered. This is the only treatment which offers any possibility of a permanent cure and should be undertaken as soon as possible. Such an operation is undertaken with two objects. In a few cases the tumour can be completely removed, and this is the result the surgeon hopes for in every case; but complete removal is possible only in about 8 per cent. of tumours and is only likely to be achieved in the case of cysts, osteomata, hydatids, endotheliomata of the dura and some of the pituitary and eighth nerve tumours; very few gliomata can be removed and practically no subcortical tumours. Tuberculomata are not suitable for excision, nor are multiple tumours. The fibroma of the auditory nerve often can be removed partially by sucking it out or curetting it from within its capsule. It is usually impossible to say whether a tumour can be removed or not until it is exposed. In the majority of cases in which removal is impossible the symptoms can be largely relieved (especially those due to excessive intracranial pressure, such as vomiting, blindness and headache), by performing a decompression operation by removing a large portion of the skull and opening the dura. This often will give considerable relief for a prolonged period. In either case the skull is opened by one of the methods described on p. 88, a good form of anæsthesia for this purpose being ether administered by means of an intratracheal catheter. Some surgeons advocate the performance of these operations under local anæsthesia; if used in conjunction with avertin or pentothal, this seems very satisfactory.

If it is thought likely that the tumour can be removed a bone flap will be cut with the object of completely replacing the bone afterwards; otherwise the bone of the skull will be cut away permanently to provide a decompression. In any case, it is so easy to close the gap in the skull later if necessary by means of Sargent's celluloid method (see p. 28), or by means of a bone graft taken from the outer table, that the cutting of bone flaps is not as essential as might be thought. The scalp flap turned down must be very large and lie over the supposed site of the tumour, and as large as possible an area of bone must be cut away, in order that as the brain bulges out when the dura is opened, owing to the increased intracranial tension, the brain substance may not be strangulated or damaged unnecessarily by being forced through a narrow opening. In the normal individual the exposed dura mater is elastic and pulsating, but if the intracranial pressure is increased by a tumour the dura will bulge into the wound and feel hard, while no pulsations will be visible. In some cases it is wise to do the operation in two stages; if this is so the dura is not opened on the first day unless a decompression is urgently needed, and the intradural portion of the operation may be put off for some days. If the pressure is very high it is always wise to reduce it as far as possible before opening the dura, either by lumbar puncture or tapping the ventricle; this will save damage to the brain if it extrudes itself. On opening the dura the brain will bulge out if the pressure is increased, and in cases where a tumour is present the convolutions in its neighbourhood will look œdematous, flattened and anæmic. If the tumour is not seen on the surface, the brain should be gently palpated by the finger, while an examination of those portions of it which are not exposed by the operation wound, but lie close by, can be made by pressing the brain aside with a transparent glass retractor. Failing this, a needle may be inserted into the brain, or a small straight linear incision into it made with a scalpel and gradually deepened for an inch or so.

If a tumour is discovered which it is thought can be removed, it should be enucleated by blunt dissection, while in some cases the increased intracranial tension is sufficient to cause spontaneous extrusion of a tumour when the dura is opened. In certain instances, *e.g.*, eighth nerve and pituitary tumours, the growth may be broken up within its capsule and then the fragments removed with a suction apparatus. The diathermy knife is occasionally useful in removing tumours and stopping hæmorrhage. When the tumour has been removed hæmorrhage from the brain is controlled either by ligatures, by muscle grafts, or by pressure with pads soaked in hot saline. If the tumour cannot be removed or cannot be discovered, a simple decompression will be done, as large an opening as possible being made in the bone and the dura being freely opened. In no case should the dura be sutured at the end of the operation, as it will be found that when the scalp flap has been sutured back into place a complete new dural covering for the brain will be formed in a remarkably short time, while the brain probably will bulge so much that no suturing would be possible. Under no circumstances must a drainage tube be inserted after operations for cerebral tumour, as it is all-important that there should be no leakage of cerebrospinal fluid. Simple decompression operations lead to considerable improvement in the mental condition, pain, vomiting, and blindness, but sooner or later the increase in the size of the tumour will cause the patient's death. It is, however, always worth doing, as the patient will live in comfort for a considerable time.

In the case of cerebellar tumours or eighth nerve tumours the posterior fossa of the skull is opened by the methods described on p. 88. In a few cases here a simple decompression will be the only thing possible, but in most cases of eighth nerve tumour the fibroma can be removed from within its capsule by curetting or sucking it out, after retracting the cerebellar lobe to one side. This retraction of the cerebellum is only possible after the falx cerebelli has been cut across. Occasionally a cerebellar cyst can be excised completely, and if necessary portions of the cerebellum can be cut away without much apparent loss of function. Never attempt to excise tuberculomata.

The mortality of all these operations is rather high, but is diminishing every year, being highest in cases where the tumour is removed and in the case of the cerebellar lesions; a cerebellar decompression has a higher mortality than any decompression performed over the cerebrum.

It must be remembered that in nearly every case of cerebral tumour we are dealing with a lesion that is going to prove fatal and to cause blindness and severe pain; so that the relief to headache and improvement to eyesight that a simple decompression gives are amply worth while; and there is always a chance of removing the tumour.

If operation is impossible, as is of course the case in all secondary tumours, all that can be done is to relieve the symptoms by drugs, such as bromide, opium, or phenacetin. Lumbar puncture frequently will relieve headache temporarily, but is by no means devoid of risk, especially in cerebellar cases, owing to the medulla being forced down into the foramen magnum by the increased intracranial pressure (see p. 46).

Radium Treatment. Secondary growths are so rare in cerebral tumours that in theory radium treatment should be very successful, but in practice it has proved disappointing. The best method is probably the superficial application of radium over the scalp over the position of a previously made decompression opening in the bone. But even this is most uncertain.

Tumours of the Pituitary Body. The pituitary body consists of two parts, an anterior glandular portion and a posterior nervous portion ; the anterior part pours an internal secretion into the blood and the posterior portion into the ventricles *via* its infundibulum or stalk. It is probable that the anterior secretion influences growth and bone formation, while the posterior secretion affects metabolism and muscle tone. Tumour formations of the pituitary gland are by no means infrequent, and inasmuch as this body is in certain senses a gland, it is not surprising to find that many of the new growths which arise in it are adenomata ; these adenomata show a special tendency to undergo cystic degeneration, in a way rather resembling those in the thyroid gland. It is, however, doubtful whether they really should not be regarded as a hyperplasia of the gland rather than a true adenoma. Malignant growths in the form of carcinoma or sarcoma are rarely seen. A rare type of tumour is occasionally found growing from the stalk of the pituitary, and rather resembling an endothelioma—it is known as an adamantinoma. Being, as it were, lodged in a separate compartment of the skull, and being shut off from the remainder of the cranium by the diaphragma sellæ, the body cannot enlarge very much in an upward direction, and it tends therefore to enlarge downwards by eroding the bone of the sella turcica ; it follows also that a pituitary tumour gives rise to only very slight increase in intracranial pressure, while most of these growths increase very slowly in size.

The symptoms and signs of such a tumour are partly pressure effects due to its situation, and partly general constitutional changes due to alterations in the internal secretions of the gland. Lying as it does immediately behind the optic chiasma, a pituitary tumour soon gives rise to pressure upon the optic fibres on each side of it, which are those passing to the nasal half of each retina ; thus one of the chief symptoms is a bitemporal hemianopia, while primary bilateral optic atrophy, with loss of sight, will occur from the direct pressure, without a preceding optic neuritis. The third, fourth and fifth nerves occasionally will be affected also. In some cases drowsiness is present and headache is usually constant and located in both temporal regions ; there is very little vomiting.

The general pathological changes in the body dependent on the alteration in the internal secretions of the gland are complicated, and depend on which part of the gland is chiefly affected. If the function of the gland as a whole is increased (hyperpituitarism) before adolescence, the result will be gigantism, and the individual will grow to a great height with big bones, poor muscular development and little intelligence ; the pituitary is usually enlarged in such a case. Most of these giants die young. If a similar hyperpituitarism occurs in an adult, the result is the condition of acromegaly (see Vol. I., Ch. XVIII.). In both these conditions the sexual glands soon become functionless.

If the function of the gland is decreased (hypopituitarism) in early life the result is dystrophia adiposogenitalis (Frölich's disease), when the child becomes fat, stunted, with absence of pubic hair, high-pitched voice, small sexual organs, no sexual power, and marked infantilism. His carbohydrate tolerance is usually very great and polyuria is marked. In later life hypopituitarism produces loss of sexual characteristics in the male, and in both sexes there are atrophy of the genital organs and loss of sexual power, mental deterioration, and excessive deposit of fat in the breasts, thighs, buttocks, etc. The skin becomes soft, dry and silky, the fingers become tapered and the hair fine. Marked sugar tolerance is present, and in the female amenorrhœa is constant. Intermediate changes partly suggestive of hypo- and partly of hyper-pituitarism are often present.

In all pituitary cases an X-ray photograph should be taken of the base of the skull, as by this means an increase in the size of the sella turcica due to the growth of the tumour will be seen. Examination of the patient's blood, sugar content, and sugar tolerance is often helpful.

Treatment. Although temporary improvement has sometimes followed the administration of various ductless gland extracts (such as pituitary, thyroid and testicular extracts), the only procedure which offers any permanent prospect of relief from the blindness and headache is operation. This is to be avoided if possible in cases of hypopituitarism ; it usually consists in relieving the pressure on the optic chiasma in order to preserve the vision by evacuating cysts or curetting away adenomata. Many routes have been adopted for approaching the pituitary fossa ; it has been done by opening the skull in the temporal region and elevating the frontal lobe in a manner rather similar to a Gasserian ganglion operation (see Vol. I., Ch. XII) ; it has been approached through the hard palate and naso-pharnyx, through the side of the nose or by temporarily reflecting the nose. The only three methods, however, which are practised nowadays consist :—

1. In the so-called fronto-orbital method and its modifications. In this method a large portion of the frontal bone is reflected in the form of a bone flap, a wedge-shaped portion of the upper margin of the orbital rim is temporarily removed, and a portion of the roof of the orbit is cut away. The frontal lobe is then gently elevated with retractors, the cavernous sinus avoided and the pituitary fossa entered. At the end of the operation the orbital rim is fitted into place again and the bone flap replaced.
2. A better method still is the frontal method, which is very similar to the foregoing, save that the orbital rim and roof are not removed. Tumours can be removed by dissection or suction by this method, and in the hands of an expert the mortality is small, except with the adamantinomata.
3. In splitting the nasal septum, by performing a submucous resection, passing up between the two layers of mucous membrane, passing across the sphenoidal sinus and opening the pituitary fossa at the back of this sinus. This only allows of a very small opening being made, but it may be sufficient to evacuate a cyst. There is no hope of removal of a tumour by this route.

HERNIA CEREBRI

This is a condition where there is a protrusion of the brain substance through an acquired opening in the skull, such an opening being due always either to an injury or operation. The condition has, therefore, nothing whatever to do with congenital openings and encephaloceles. Such a protrusion is always due to increased intracranial pressure, this increase of pressure being almost always caused by diffuse infection of the brain (encephalitis) or of the meninges : this is often associated with the presence of foreign bodies such as pieces of shell or fragments of bone in the brain, and accompanied by great œdema of the cerebral tissues. Such a cerebral hernia is more commonly seen through a small opening in the skull than through a large one, but the condition must not be confused with the bulging of the brain which will occur after a decompression operation which has been performed to relieve intracranial pressure. When due to a compound fracture or other infected opening in the skull, the increased intracranial pressure forces out a portion of œdematous and inflamed brain tissue through the opening in the dura and the bone, and usually through the wound in the scalp also, so that the brain appears as a soft, red or dusky tumour covered with granulations and flakes of pus, which increases in size rapidly, and may reach the size of a cocoanut. As long as the extruded portion is small, the tumour pulsates synchronously with the heart, this pulsation being clearly visible, but when it becomes larger, the edges of the opening through which it protrudes will squeeze it and the pulsation will cease, while the extruded portion sometimes will become strangulated and necrosed. In its early stages it will also increase in size when the patient strains or coughs. In some cases the protruding mass does not consist entirely of cerebral tissue, but partly of exuberant granulations, either growing from the brain, from the dura or the bone (**fungus cerebri**). If the hernia progresses in size, mental changes, diffuse encephalitis and death in coma will follow. A few cases will recover, but the patient will be left with an adherent scar, so that there will be a great liability to epilepsy or insanity. In some cases a prolongation of the lateral ventricle will pass out into the herniated portion. Infection is then particularly liable to

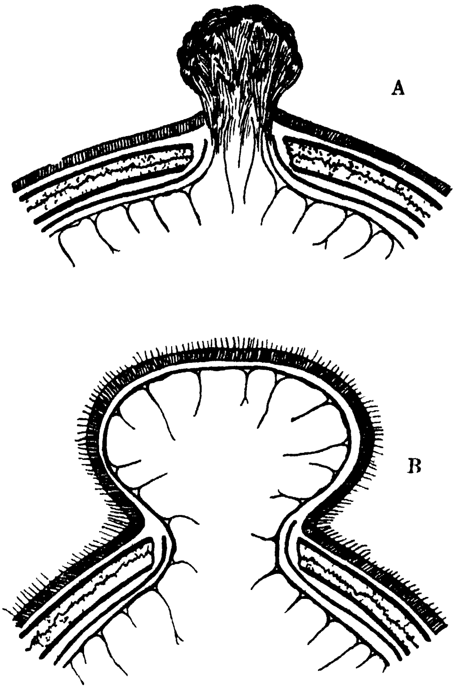

FIG. 10. (A) Hernia cerebri. Here the granulating brain substance is actually protruding through the dura, skull and scalp. (B) The results of a decompression-operation, showing the intact scalp.

spread into the ventricle, and it is not likely that the patient will survive. The prognosis in all cases is grave, as a considerable degree of meningo-encephalitis is always present. This is quite a different condition from the bulging of the brain which follows a decompression operation performed for cerebral tumours, as here the brain has its normal covering of scalp and newly-formed dura and is not infected.

Treatment. Every effort must be made to prevent this condition arising by preserving asepsis in wounds which involve the meninges (see p. 20). Once the hernia has developed it should be dressed with absolute alcohol or painted with 40 per cent. formalin solution, either of which will dry it up and in time cause it to diminish in size; carbolic acid (1–60) and hypertonic saline dressings are also useful. Any cerebral abscess which may be present must be drained. The herniated portion should never be cut away unless it is actually sloughing or is pedunculated, for if this is done it probably will re-form, while the infection may be spread and the ventricle be opened. In some cases the bony opening may be enlarged by cutting it away with forceps, so that the intracranial tension may be relieved, while gentle pressure may be applied to the hernia itself. It is not unknown after the hernia has persisted for many weeks for it quite suddenly to shrink in size and for the wound to granulate over and heal. After such a hernia has withdrawn and the wound healed it may be necessary to set free dural adhesions and to close the gap in the skull by means of Sargent's operation (see p. 28) or by means of bone grafting. Various forms of traumatic epilepsy are likely to arise and need appropriate treatment (see p. 27).

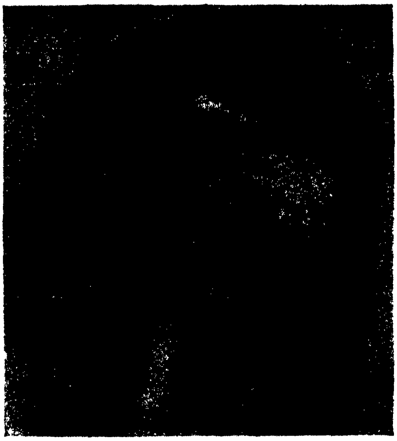

FIG. 11. Hernia cerebri following a septic compound fracture of the skull in which the dura was torn.

CHAPTER II

INJURIES AND DISEASES OF THE SCALP AND SKULL

Surgical Anatomy of the Scalp. By the scalp is denoted all the soft tissue covering the vault of the skull, and it consists of three layers:—the skin with its hairy covering, the layer of tissue which represents the subcutaneous tissues elsewhere and which here consists of a thin layer of tough fibrous tissue, containing within it some coarse fat, and deep to this the epicranial aponeurosis, which is directly connected to the occipito-frontalis muscle at each end. These three layers are so intimately fused together that they constitute to all intents and purposes a single structure, which can be moved backwards and forwards to a small extent by the action of the occipito-frontalis (epicranius) muscle. Under this aponeurotic layer is a space which is occupied by some loose areolar tissue, containing numerous small vessels, and it is this loose layer of tissue which permits the scalp proper its freedom of movement; this space under the aponeurosis is sometimes referred to as the "dangerous area of the scalp," as suppuration or hæmorrhage is liable to spread far and wide in this situation. Beneath this loose areolar tissue is the thin pericranium or periosteum of the cranial bones. This membrane is closely attached to the bones of the skull along the lines of all the cranial sutures. The occipito-frontalis muscle, and in places its aponeurosis, is attached in front to the superciliary ridges, behind to the superior curved line of the occipital bone, while at the sides it blends with the temporal fascia at the level of the zygoma, and through this receives some slight attachment to the bone. It will thus be seen that effusions, suppurative or hæmorrhagic, under the epicranial aponeurosis can easily spread forwards, backwards and laterally as far as the attachments of the muscle above described, but that, on the other hand, an effusion under the pericranium is limited by the attachments of this membrane to the cranial sutures and thus usually will spread only as far as the limits of that cranial bone over which it commences.

The scalp has a particularly free blood supply, the vessels running in the dense subcutaneous tissue superficial to the aponeurosis, so that extensive laceration can occur without sloughing of the tissues.

The arteries anastomose freely with one another and across the middle line, and the toughness of the fascia in which they run is sufficient, when they are cut, to keep them patent and prevent their retracting; thus hæmorrhage may be particularly free. They are derived in front from the supraorbital branch of the internal carotid, and at the back and sides from the superficial temporal, posterior auricular and occipital branches of the external carotid. As the main branches of these vessels run for the most part vertically upwards towards the vertex, incisions in the scalp should, as far as possible, be made parallel to them. The veins draining the scalp are many, and their importance lies in the fact that they have free communication by means of "emissary veins" with the intracranial venous sinuses, and thus infective conditions on the scalp may sometimes be transmitted to structures inside the skull and vice versa. These emissary veins are found in the mastoid, condyloid and occipital regions of the skull, where they pass to the lateral sinuses, and the parietal and nasal regions, where they pass to the superior longitudinal sinus, while there is a communication at the internal angle of the orbit between the facial veins and the cavernous sinuses.

The scalp is supplied with sensory nerves chiefly by the fifth cranial nerve through its supra-trochlear, supra-orbital and auriculo-temporal branches, while the great and small occipital nerves also supply a portion of the skin at the back.

The lymphatic vessels from the scalp pass chiefly to the preauricular, occipital and posterior cervical glands. Thus enlarged glands which are due to conditions in the scalp are usually found in the posterior triangle of the neck, though they may be seen occasionally in the submaxillary and deep cervical regions.

The pericranium has, as far as we know, no power of forming new bone, nor does it provide the cranial bones with much of their blood supply. Except at the sutures it is very loosely attached to the bones over which it lies. The outer layer of the dura acts as a pericranium to the inner side of the bones.

INJURIES OF THE SCALP

Hæmatoma. A hæmatoma of the scalp results from a simple contusion of the head, without any laceration of the skin, and it is thus usually due to minor degrees of external violence by blunt instruments, blows and falls. The condition is occasionally seen in new-born children, as a result of an injury to the head during birth, either in passing through the maternal passages or from the use of forceps. A hæmatoma may occur in three situations:—

(*a*) The superficial form occurs in the superficial layers above the aponeurosis, and owing to the density and adherence of the fascia here the hæmatoma is small and cannot spread far. It thus gives rise to a firm, small, tender swelling, with discoloured skin over it, at the actual site of the injury. Such a hæmatoma soon disappears spontaneously.

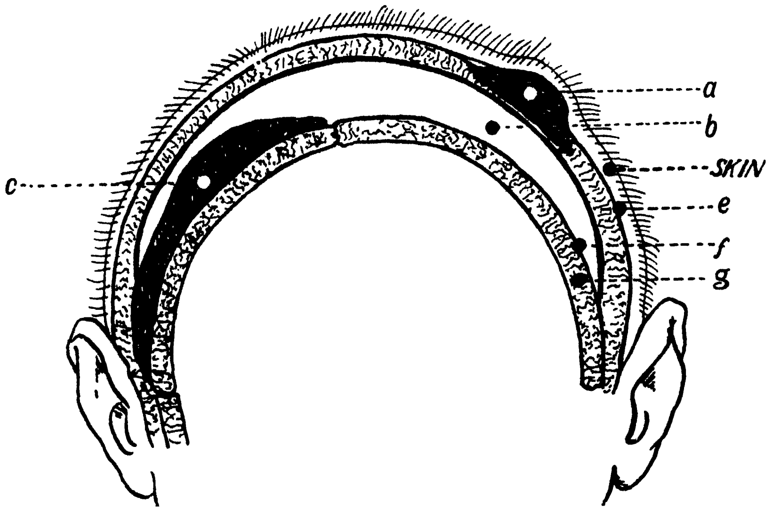

FIG. 12. Diagram of effusions and hæmatomata of the scalp: (*a*) subcutaneous; (*b*) subaponeurotic (in the dangerous area); (*c*) subpericranial; (*e*) is the aponeurosis of the scalp; (*f*) is the pericranium; (*g*) is the skull.

(*b*) A much more important form is the subaponeurotic hæmatoma, and this occurs when lacerated vessels bleed into the loose areolar tissue of the "dangerous area" beneath the aponeurosis. Such a hæmatoma is not infrequently due to a fracture of the underlying skull, and it is only limited by the attachments of the aponeurosis. If large, therefore, it will form a big, soft, fluctuating swelling, which may gravitate towards the eyebrow, the zygoma, or the occiput, and give rise to what appears to be a loose bag of fluid in these situations, with the scalp appearing to float over it; if a large artery is torn this swelling may pulsate. After a few days such a hæmatoma will appear to localise itself to that area where it was at first most prominent, it will become surrounded by a raised, firm, boggy area, due to blood clot, and will ultimately become completely absorbed. In a few instances, however, this will not come to pass, and the condition, after decreasing in size up to a certain point, will become encapsuled with a layer of fibrous tissue round it, and in time will be converted into a blood cyst containing a yellowish-red serum.

(*c*) A less common form is that where the hæmatoma occurs under the pericranium, and in this case the special name of a **cephalhæmatoma** is given to it. In this case the effusion is limited to the bone over which it commences by the pericranium dipping down into the sutures round that bone. It is most commonly seen over one of the parietal bones in an infant, as a soft, fluctuating swelling corresponding roughly in shape to a parietal bone, following some minor injury at birth. After a time it will surround itself with a raised, indurated margin, which is boggy to the feel and consists of fibrin and blood clot, and when this has occurred the soft, unclotted, depressed centre with the raised boggy edge round it will closely resemble a depressed fracture of the skull. This resemblance to a depressed fracture is also sometimes seen in the case of the other forms of hæmatoma of the scalp. However, by observing that the edge of the swelling is really raised above the surrounding part of the skull, that it is œdematous and pits on pressure, or even can be dispersed by a firm and continued pressure, and that the apparently depressed centre really consists of bone on the same level as that of the rest of the skull, the two conditions can be distinguished. If there were a depressed fracture, the finger would almost certainly feel the hard, irregular edge of the bone at the site of fracture, while it must be remembered that, except in children, it is exceedingly rare to meet a depressed fracture which is not compound. It will be found sometimes that both a depressed fracture and a cephalhæmatoma are present. If doubt still exists and any trace of cerebral symptoms is present, it is quite justifiable to make an exploratory incision and examine the bone by turning down a flap of the scalp. In these subpericranial hæmatomata it sometimes will be found, after all blood has been absorbed, that a small amount of ossification at the edges of the hæmatoma has occurred, giving rise to some thickening and irregularity of the bone. Great care must be taken to distinguish this from a somewhat similar condition, which is known as a traumatic cephalhydrocele (see p. 73).

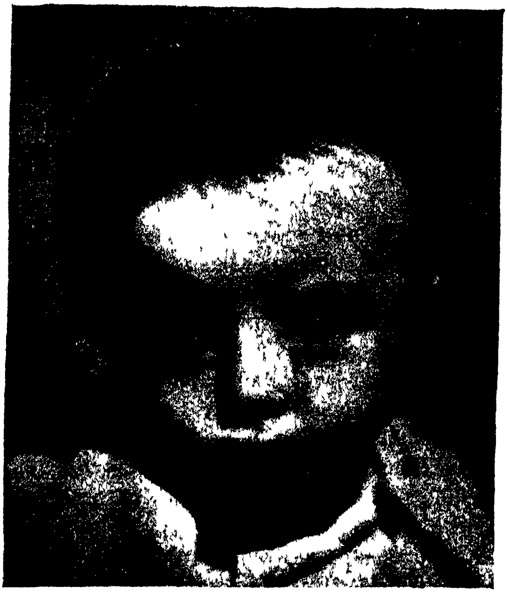

FIG. 13. Subaponeurotic hæmatoma in a child. The extravasation is limited to the frontal region

It must be remembered that, though these forms of hæmatoma are of no gravity in themselves, they are often associated with grave injuries to the skull and brain underneath. In association with a fracture of the skull and intracranial hæmorrhage (especially in children), a hæmatoma under the scalp will sometimes provide a method of escape for the intracranial hæmorrhage and thus lower intracranial pressure by acting as a safety valve.

It will be found sometimes that the shape and situation of a hæmatoma of the scalp will give a valuable indication of the state of the skull underneath. For instance, a linear hæmatoma on the head is very strong evidence of the presence of a linear fracture of the skull underneath, while an extensive hæmatoma confined to the temporal region is often associated with a fracture of the temporal fossa and an injury to the middle meningeal artery underneath. Sometimes a temporal hæmatoma of this kind will pulsate, and this is conclusive proof that the middle meningeal and the temporal region of the skull are damaged.

Treatment. This consists in rest and the use of some evaporating lotion, while the absorption of effused blood will be assisted by gentle massage and firm pressure. Suppuration is most unlikely to occur unless a wound is present.

Wounds of the Scalp. The usual varieties of wounds—punctured, incised, contused, lacerated, and gunshot—are met with in the scalp, but it is important to remember that the scalp is so tough and so tightly stretched over the bone which lies immediately beneath that a blunt weapon, such as a truncheon or stick, will often cause a wound which appears to be as cleanly cut as if it had been produced with a knife. This is especially seen near the eyebrow. It is important in the case of any scalp wound to ascertain how deep it goes, and which of the layers are divided, while the presence of the emissary veins renders the supervention of any infection of a scalp wound serious, on account of the liability of intracranial structures to become involved. As scalp wounds may be produced in a variety of ways, their shape varies greatly, and they are especially liable to have dirt and foreign bodies ground into them. If the skin and superficial fascia only are divided and the aponeurosis is intact, the wound will not gape, and should therefore heal quickly, but drainage, if required, is difficult and small foreign bodies are particularly likely to be left in the wound. The results of infection in such a wound are also far less likely to be serious than if the deeper structures were involved. If, however, the aponeurosis is divided and the "dangerous area" opened, the wound is more likely to gape, and infection, if it supervenes, will lead to more serious consequences, as there may be widespread cellulitis and suppuration all over the vault of the skull and under the true scalp. If the wound also passes through the pericranium, infection may spread to the bones, causing osteitis and necrosis, and the intracranial contents are still more likely to be involved. The vascular supply of the scalp is so good that sloughing is highly unlikely, and quite large flaps of tissue may be torn, bruised or lacerated, and in some cases almost completely detached except for a narrow pedicle, and yet when washed, rendered aseptic and returned to their place they almost certainly will retain their vitality. Bleeding from scalp wounds is very profuse, and often one of the most troublesome symptoms. The vessels are held rigidly by the dense subcutaneous tissue and are unable to retract and contract, and for this same reason their ligature by ordinary methods is often difficult. In every case of scalp wound, not only is it exceedingly important to find out how deeply the wound has penetrated, but the likelihood of additional damage to the skull or intracranial contents must always be borne in mind, and a careful examination must be made to ascertain the condition of these structures.

Complete Avulsion of the Scalp. The whole scalp is sometimes torn off the head in women whose hair has been caught in machinery. The tear usually occurs just above the ears and through the eyebrows, and the skin and aponeurosis are usually cleanly torn away; in rare cases the pericranium has been detached also. If the scalp is completely separated, replacement is, of course, useless, and skin grafting will have to be employed later on in order to cover the denuded area, but as long as any attachment to the intact scalp remains the portion detached should be replaced, after being as far as possible rendered aseptic, and when sutured into place it is quite likely that it will retain its vitality.

Treatment. The first indication is to secure, as far as possible, asepsis of the parts concerned, and in order to do this the hair should be cut away from the immediate neighbourhood of the wound and the wound be washed carefully with an antiseptic solution. Peroxide of hydrogen will be found useful for its cleansing effect in removing dirt, and 1-20 carbolic or iodine may be employed in an endeavour to purify the tissues. The wound edges must then be excised, while undermined flaps must be explored and drained by counter-openings, foreign bodies searched for, and a careful examination made to ascertain which of the scalp layers are injured and whether the bone is damaged. In many cases an anæsthetic will be necessary. The free hæmorrhage must be controlled, and as it often will be found difficult to put forceps on vessels in the scalp and ligature them in the ordinary way on account of the rigidity of the surrounding tissues, it is better in most cases to underrun the vessels with stitches. It is inadvisable to cut away any portion of the scalp that retains an attachment to the intact portion, however narrow, for, when cleaned and put back into place, it will very likely survive. Minor degrees of hæmorrhage often can be controlled by the pressure of dressings with a tight bandage. After hæmorrhage has been stopped and asepsis secured, the wound should be sutured, not too tightly, and small gaps may be left to provide for drainage.

In many cases the actual suturing of the scalp is sufficient to stop all bleeding. An essential part of the treatment consists in making a careful examination to ascertain whether a fracture of the skull is present, and to do this both the probe and the gloved finger should be employed, while care must be taken not to mistake one of the normal sutures for a fissured fracture.

Complications of Scalp Wounds. The complications of scalp wounds are all due to infection. In some cases the infection is localised to the immediate neighbourhood of the wound, and does little more than render its edges swollen, red, œdematous and painful, but in other cases severe spreading cellulitis, osteomyelitis, meningitis and other forms of intracranial infection may set in; as a rule it is only the deeper wounds, such as those which implicate the subaponeurotic layer or the pericranium, which give rise to these serious results. The varieties of suppuration which may occur in the scalp and the various forms of infection of the bones and intracranial contents will be considered later. The onset of infection in a scalp wound usually causes a very definite degree of toxæmia, and before any change may be visible in the wound there will be pain, throbbing and heat locally, and chilliness and restlessness, with rise of temperature and pulse rate; later, œdema, swelling and tension of the stitches will occur. Œdema is often seen first on the forehead and eyelids, and when this occurs a short time after a wound in the scalp, it is almost certain evidence that some degree of infection has set in.

Treatment. If it appears certain that the wound has become infected, the greater number of the stitches should be removed and the wound encouraged to gape open, in order to provide drainage. Hot fomentations and antiseptic dressings must then be employed, and unless one of the more serious complications sets in healing will not be long delayed.

DISEASES OF THE SCALP

Suppuration of the scalp is common, being due in most cases to an external infection, although occasionally it arises from disease of the underlying bones. In a great many instances it is seen as a complication of a wound of the scalp (see p. 58), and the position and spread of any abscess which may form is controlled by the same anatomical features as we have mentioned already in connection with hæmatomata. We have, therefore, three forms of abscess in connection with the scalp :—

(*a*) *A subcutaneous abscess.* These are small and localised, with considerable local pain, tenderness and œdema. They frequently will be found to occur, apart from wounds, in feeble and unhealthy children, in whom they are usually associated with impetigo, pediculi, eczema or chronic dermatitis. In such cases they are not necessarily acute and painful, but frequently develop slowly and painlessly with very little œdema, and as a rule, before they become very big, the skin becomes red and thin and then gives way. So painless are they that it is thought, in some cases at any rate, that these small abscesses of the scalp in children are due to a mixture of pyogenic and tuberculous organisms. The treatment consists in incising them as soon as possible, in which case they usually will heal rapidly, though occasionally, in particularly unhealthy children, a troublesome superficial ulcer will follow.

(*b*) *A subaponeurotic abscess* is much more serious. Here the pus spreads widely, and may point in the neighbourhood of the eyebrow, the temporal crest, the zygoma or the occiput. This condition is hardly ever seen, except in connection with infected wounds of the scalp or disease of the cranial bones. One or more incisions should be made in the situations where the pus appears to be pointing, due consideration being paid to the position of important arteries and nerves.

(*c*) *A subpericranial abscess* is also serious, and is nearly always associated with injury or disease of the cranial bones. Such an abscess is limited to the bone affected, and although the pericranium may be widely stripped up, it will quite often be found that necrosis does not occur. The treatment of this condition is also incision at the most suitable points.

Cellulitis and erysipelas are common on the scalp and have the same characteristics as elsewhere (see Vol. I., Ch. V.). They may give rise to great œdema of the eyelids and face.

Syphilitic ulcers are also met with. They have the same characteristic as gummatous ulcers on other parts of the body, and though they are occasionally the result of the breaking down of gummata in the soft tissues of the scalp they are far more commonly due to gummatous disease in the underlying bone. Syphilis of the skull and scalp is by no means as common now as it was several years ago, on account of the earlier and far more efficient treatment the disease now receives.

Rodent ulcer and lupus are not infrequently seen on the scalp ; usually, however, they do not commence there, as it is far more common for them to spread on to the scalp from the face.

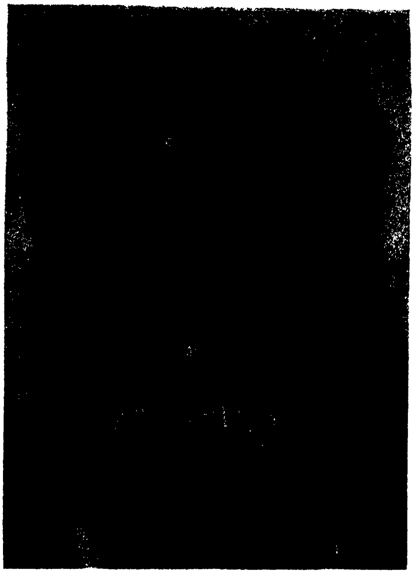

FIG. 14. Sebaceous cyst of the scalp in the midline and resembling a dermoid cyst.

Cystic and Solid Tumours. *Sebaceous cysts* are very common on the scalp, being known in this situation as wens. They are here specially liable to suppuration and ulceration, in which case they may cause a **Cock's peculiar tumour** (see p. 64). They are frequently multiple and may attain a large size. A full description of them will be found in Ch. VIII, Vol. I., but it is important to note that when they occur on the scalp they are nearly always bald, partly because they produce atrophy of the hair follicles, and still more because, growing as they do in the skin, they stretch the skin over themselves, and may therefore be regarded as growing up between the hairs. The treatment is excision, which is done best by removing an elliptical portion of the skin and completely removing the cyst wall. It is most important that all the cyst wall should be removed, otherwise a sinus will result or the cyst recur.

Dermoid Cysts. These also are by no means uncommon on the head, but they do not occur all over the scalp, only being seen near the anterior or posterior fontanelles, at the root of the nose, near the occiput, at either angle of the orbit, near the ear, or in the temporal region. These cysts are fully described in Ch. VIII., Vol. I., and though essentially and by nature congenital, they do not usually become very large, and are often not noticed until over the age of ten. They are, of course, not attached to the skin, but are closely fixed to the bone underneath, and as they sometimes lie over a gap in the skull, a pedicle connecting them with the dura mater is sometimes found, in which case they may be mistaken for a meningocele. They have, however, no impulse on coughing, neither are they reducible on pressure or pulsatile. Nearly all dermoid cysts on the scalp which have been present for some time will be found to be associated with a slight hollowing out of the bone on which they lie. This can usually be felt in the form of a little bony ridge round the margin of the swelling, and, when felt, is almost diagnostic.

Treatment. No treatment will cure a dermoid cyst except excision, but as a rule it is wiser to wait until after the age of puberty before doing this; especially is this so if there appears to be an opening in the skull underneath, for in this case it is quite likely that after puberty this bony opening will close and the operation will become simpler.

Simple serous cysts are occasionally seen in the scalp, but as they nearly always correspond to one of the sutures of the skull, it is thought that they probably are meningoceles which have been shut off from the interior of the skull during development.

Various forms of vascular swellings are commonly found on the scalp.

Aneurysms, either true traumatic aneurysms or arterio-venous communications, are occasionally seen. They do not as a rule become big, and are best treated by excision (see Vol. I., Ch. X.). At one time these were comparatively common in the superficial temporal artery as a result of the practice of bleeding from that vessel. A dilated and tortuous condition of one of the scalp arteries, and known as an **arterial varix**, is sometimes seen; this is most common in the superficial temporal vessel and is best treated by excision (see Vol. I., Ch. X.).

Cirsoid Aneurysm (see also Vol. I., Ch. X.). This is a most curious and rare condition, which is hardly ever seen except on the scalp, and then is usually found in the auriculo-temporal region. From there it may spread a long way, on to the face, down the neck, or even over the greater part of the scalp. Its cause is unknown, but in many cases there is a history of an injury, while it may have been preceded by a nævus. It gives rise to a swelling under the skin, consisting of a dense mass of large tortuous, distended, bluish arterial vessels, pulsating with the heart; it can be emptied by pressure and fills up again at once when set free. It appears to contain large spaces into which the arteries open without the intervention of capillaries. The rate of growth is variable, but it steadily increases in size, and the patient complains of rushing noises in the ears, giddiness and headache. The skin becomes thin and the hair falls out, while in a few cases fatal hæmorrhage has occurred owing to ulceration. A well-marked thrill usually can be felt, and on auscultation a roaring, humming bruit is heard. The swelling often decreases in size on compressing the carotid vessels, and increases if the patient lowers his head. The growth shows a distinct tendency to erode the bone it is in contact with, probably causing a pressure atrophy. Frequently it will be found that big vessels enter the swelling from the bone itself.

Treatment. The treatment is very difficult, as any operation may sometimes be followed by appalling hæmorrhage. The ideal treatment would be complete excision, with ligature of the vessels supplying the mass, but this is usually impossible in any except the smallest cases. Ligation of the main afferent vessels, or even of the external or common carotids, is usually followed by recurrence, owing to the free anastomosis of the scalp vessels. Ligation of vessels combined with electrolysis (see Vol. I., Ch. X.) has at times produced good results. In other cases the tumour may be excised piece by piece, with intervals between the different operations, or the dilated vessels may be cut across in many places and their ends tied. Subcutaneous sutures may be put in in groups round the whole swelling in the hope that, when tied, they may cut off the blood supply. A rubber tourniquet applied round the skull as low as possible often will render one of these operations easier. Many other procedures have been tried for this condition, such as injecting boiling water into the external carotid, heavy doses of X-rays, and diathermy (see Vol. I., Ch. XXIII.).

Nævi. These are common on the scalp and resemble nævi elsewhere (see Vol. I., Ch. VIII.). They are sometimes situated over one of the fontanelles, and in this case they may resemble a meningocele, as they derive a transmitted pulsation from the dura underneath. It will not be, however, a true expansile pulsation. The "port wine" birth-mark so often seen on the face rarely involves the scalp proper.

Adenomata are not uncommon on the scalp, especially in the temporal region. These usually arise in sebaceous or sweat glands and give rise to a firm tumour of a red or purple colour covered by a thin shining skin (*tomato tumour*, see Vol. I., Ch. VIII.). They sometimes ulcerate and fungate, giving rise to a large granulating swelling with a foul discharge, and in this case they may resemble an epithelioma closely. In other instances they actually do become malignant, the malignancy being of a low grade (sebaceous carcinoma). They are best excised.

Cephalhæmatocele. This is a very rare tumour which is formed of cavernous venous spaces in the scalp communicating through a hole in the bone with the superior longitudinal sinus. It gives rise to a bluish compressible tumour in the mid-line of the skull, with an impulse on coughing, and the hole in the bone is sometimes palpable. It must be excised and the communication with the sinus tied. Sometimes it is easier to expose the longitudinal sinus and tie it in front of and behind this communication.

Papillomata are common on the scalp and give rise to a hard, warty growth sometimes resembling a horn. They may cause trouble through catching in the comb or interfering with the hat. As they sometimes become malignant, they are best removed; this is easily done under local anæsthesia.

Lipomata are rare in the scalp. They are usually situated over the frontal bone, and in this situation are nearly always subperiosteal. They thus give rise to flattened, slow-growing, lobulated, painless, soft tumours, not definitely fluctuating, attached to the bone, but not to the skin, and with a rolled border. They are easily removed.

Plexiform neuroma gives rise to a soft, flabby tumour in the course of a cutaneous nerve, very often the supra-orbital nerve. Many of these cases are exceedingly fibrous and can hardly be distinguished from fibromata. Sometimes they become very large and hang down in pendulous folds over the face or ear, and in this case the condition is known as a **pachydermatocele.** In all cases they are best excised, but if very large they can be treated fairly satisfactorily with radium plaques or deep X-ray therapy, either of which will lead to a great diminution of size, but are often followed by permanent defilation of the area.

Many of these tumours contain, as well as fibrous and nervous tissue, a certain amount of nævoid and myxomatous structure, and therefore they may be difficult to classify.

Sarcoma on the scalp is nearly always an extension from the bone underneath, though occasionally secondary sarcomatous nodules will be found arising in the scalp distinct from the bone.

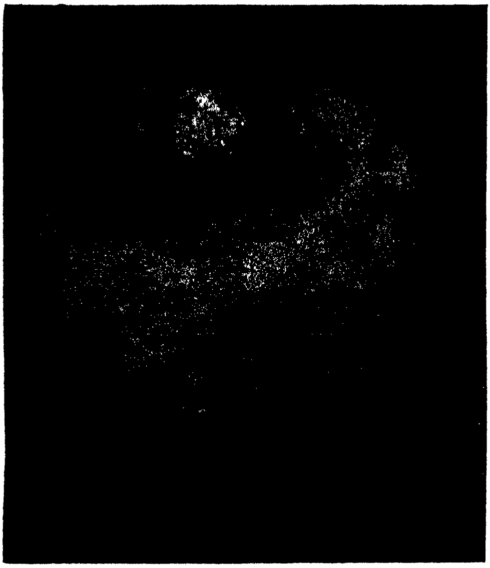

FIG. 15. Granulating and fungating sebaceous cyst of the scalp (Cock's peculiar tumour).

Epithelioma on the scalp is not uncommon, and may arise in a wart, a scar (either of lupus or burns), or from an ulcerated sebaceous cyst. It is of the squamous type and resembles this condition elsewhere (see Vol. I., Ch. VIII.). It is often found in comparatively young patients, grows slowly, and should be removed as soon as possible.

Rodent ulcer is usually only found in the scalp as an extension from the face.

Cock's Peculiar Tumour. This is a mass of firm, sprouting granulations which sometimes occurs as the result of chronic suppuration in a sebaceous cyst which has discharged on to the surface. The granulations are firm, red and raised, with a profuse discharge. It will resemble an epithelioma, but there is no enlargement of lymphatic glands, no infiltration of surrounding tissues, and no tendency to spread (see Vol. I., Ch. VIII.).

Air-containing Swellings (pneumatoceles) are occasionally seen in the scalp, the air in them having come from one or other of the air-containing spaces in the skull. The mastoid antrum and air cells and the frontal sinuses are the most common sources of this air, and the condition is usually the result of a perforation of the bone over these air spaces, either as the effect of injury or sometimes of other pathological processes (frequently long-continued suppuration). Air passes under the pericranium and gives rise to a tense rounded swelling, fluctuating, resonant on percussion, and reducible on pressure; there is often a distinct impulse on coughing or straining. The swellings are usually painless, and unless other complications, such as suppuration, supervene, they do not require any treatment other than that of the cause.

As the result of similar processes, if the pericranium is also penetrated or torn, surgical emphysema of the scalp will result, the air infiltrating the loose areolar tissue under the aponeurosis and giving rise to the characteristic feeling (see Vol. I., Ch. VII.). This condition is not serious and does not require any treatment.

INJURIES AND DISEASES OF THE SKULL

Surgical Anatomy. The skull is irregularly ellipsoidal in shape and consists of three main portions, the vault, which is rounded and devoid of openings, the base, which is irregular and full of perforations and cracks, and the facial portion. Its floor or base is divided into three separate fossæ, the anterior, which contains the frontal lobes of the brain, the middle, which contains the temporo-sphenoidal lobes, and the posterior fossa, which contains the occipital lobes, the cerebellum, pons and medulla. Thus the vault is strong, elastic and resistant, and is seldom broken unless dented directly inwards; the base, on the other hand, is liable to split and crack very easily, the cracks tending to run through the various fissures and foramina.

The skull consists of two tables, an outer and inner, separated from each other by a layer of loose cancellous bone, known as the diplöe. The thickness of the whole skull varies enormously in different parts and in different patients. The outer table is the most elastic portion, is smooth, and derives its blood supply partly from the pericranium and partly from the diplöe. The inner table is thinner and more fragile, is grooved on its inner surface by certain arteries and venous sinuses, and it derives its blood supply from the diplöe. The diplöe is very vascular and contains within its substance numerous arteries and veins; of these latter, some drain into veins outside the skull, others into the intracranial venous sinuses, while still others drain into the emissary veins. The existence of these emissary veins renders it possible to reduce the vascularity of the structures within the skull by leeching or bleeding.

INJURIES OF THE SKULL

The bones of the skull are frequently liable to injury, and the resulting lesions are either contusions or fractures. Contusions of the skull, of course, necessarily occur at the point struck, but fractures may occur either at the injured spot or they may occur as the result of indirect violence in parts of the skull quite distant from the injured point, as is seen in the case of fissured fractures and the common fractures of the base of the skull, as the result of a blow on the vault. Fractures of the skull are not in themselves necessarily at all serious, but they derive their grave features from the fact that it is highly probable that one or other of the intracranial structures will be also injured, and in many cases the symptoms of the associated intracranial injury outweigh everything else and colour the whole picture. Similarly, we shall see that when the question of treatment arises, *the treatment of a skull injury is very largely subordinate to the treatment of the associated intracranial lesion.* It must be remembered that any form of skull injury may coexist with any form of intracranial damage, but in practice it is usually found that certain types of skull injury are more commonly associated with certain varieties of intracranial lesions than with others, and the converse also holds true.

Contusions of the Skull. These result from falls or blows and are in themselves more or less insignificant, as usually the damage done to the soft tissues, namely, the scalp, the meninges or the brain, completely overshadows the bone injury. Serious after-results, however, may follow at times, such as a peculiar condition causing growth and dilatation of the diploic veins at the seat of an injury and giving rise to severe congestive headaches. This condition can be diagnosed by X-ray films, when it shows as a rarefied area in the skull, and can be cured by chiselling away the outer table and plugging the veins with bone wax. Inflammatory conditions of the damaged bone will sometimes be set up as the result of injury, and acute osteitis, syphilitic or tuberculous osteitis, or even sarcoma, have not infrequently been found to follow bruises of the skull bones (see p. 84). Extradural abscess, meningeal hæmorrhage, or a variety of cerebral lesions also may be produced (see Chapter I.).

Fractures of the Skull. It is usual to classify the fractures of the skull under two separate types, fractures of the vault and fractures of the base of the skull, the latter being rather the more common. Fractures of the vault may be either fissures, depressed fractures (of various types), or a combination of these two, but fractures of the base are nearly always pure fissures; also it must be remembered that these fissures at the base of the skull vary greatly, both in complexity, direction and situation, and it must not be forgotten that in many cases both the base and the vault are involved by one fracture. Any form of fracture of the skull is liable to be accompanied by any of the many forms of intracranial damage; in some cases (especially in fractures of the base) the intracranial condition will dominate the whole picture, both as regards signs, symptoms and diagnosis, whereas in other cases (such as localised fractures of the vault) the skull injury itself may appear to be the more important feature. Fractures of the skull will be, of course, either simple or compound; those of the vault may be either the one or the other, but those of the base are far more commonly compound than simple. Fractures of the vault usually can be diagnosed by sight and touch, as the vault is accessible to these methods of examination, but in the case of a fractured base usually we cannot examine the bone directly, and then have to rely upon indirect signs and symptoms. A fractured base does not usually show in an X-ray picture, but in most cases of fractured vault the fracture can be seen in a good film There are, however, several other structures which may closely resemble a fracture in an X-ray photograph, such as normal sutures, Wormian bones, arterial canals or scratches on the film. It should be remembered that fractures are not as a rule branched or dentate.

FRACTURES OF THE VAULT OF THE SKULL

These fractures are exceedingly common injuries, nearly always produced by direct violence, and the nature of the fracture will depend very largely upon the shape of the object which causes the break and the amount of violence employed. Such a fracture is nearly always at or close to the spot where the impinging object strikes the skull. In addition to the two main varieties of simple and compound, it is usual to divide fractures of the vault into the types of *fissured, stellate, punctured, depressed, elevated and comminuted,* and in many cases these different varieties are combined, while the names explain themselves. The type of fracture which occurs in any injury depends upon the nature of the violence and the strength of the skull at the point hit. Depressed fractures are nearly always comminuted, and two special forms of these are sometimes described, the "*pond fracture*" and the "*gutter fracture*"; but the most important point about a fracture of the skull is really whether it is simple or compound rather than the exact form of damage done to the bone. If a fracture is produced by a moderately sharp or pointed instrument, and a considerable amount of force is employed, extensive damage is done to the bone at the spot struck (punctured fracture), but it is not likely to be cracked or splintered for any considerable distance around. On the other hand, if it is struck by a blunt object the force of the blow is more diffused, and the skull tends to be bent or deformed momentarily by it. A certain amount of this bending of the skull may occur without an actual fracture, and then its elasticity will allow it to recoil afterwards and resume its proper shape, but if the limits of its bending powers are passed the bone will be broken over a wide extent, while comminution and depression of fragments will very probably occur and fissures may spread in different directions, this whole process of bending, recoil or fracture occupying, of course, only an instant of time. It will be found in nearly all fractures where both tables are involved that a larger area of the inner table is splintered than of the outer table, for the inner table is thinner, more brittle, less supported on its inner side, and the lines of force, as they pass through the skull, tend to spread out laterally from the point struck and involve a wider area. Cases have been recorded in which the inner table has been fractured without the outer table being damaged (Von Bergman).

There are, however, other ways in which fractures of the vault may be produced. When, for instance, a high velocity bullet of small size enters the skull the impulse which its sudden impact conveys to the semi-fluid brain causes an enormous instantaneous rise of pressure within the skull, and in this way it has sometimes happened that large portions of skull (sometimes the whole vault) have been comminuted or blown out without being touched by the bullet at all. Occasionally fractures of the vault are seen at some point other than the spot where the violence has been applied, the fracture then being due to indirect violence. Though not common in the case of the vault, this is the most common way in which a fracture of the base is produced. Inasmuch as the skull is slightly elastic and the semi-fluid brain and cranial contents are incompressible, it follows that if the skull is depressed at one spot by a more or less diffused force only acting for a very short time—as in the case of a fall on the head or a blow with a blunt instrument—a corresponding bulging of the bone must occur at some other spot. Now the elasticity of the skull varies considerably in different parts, owing to the differences in the thickness and structure of the bone, and so it may happen that if the bulged part of the skull is less elastic or less strong than the depressed portion, a fracture by bursting may occur there, which will be at some distance from the point of injury (most commonly at the opposite side of the skull).

The process of repair in fractures of the skull takes place in exactly the same way as it does in any other fracture (see Vol. I., Ch. XIV.), with the exception that there is only a very small amount of callus formed. The inner table appears to have a greater tendency to form callus than does the outer, while so good is the blood supply that completely separated fragments of the bone show no tendency to undergo necrosis unless infection is present, and they usually in time will become united to the surrounding bone. If a complete gap is left in the skull it will become filled in rapidly by a firm mass of fibrous tissue, as is often seen after an extensive injury or a decompression operation. A certain amount of slow ossification may occur in this fibrous membrane, the bone appearing to spread in from the osseous margin of the opening, but it is not likely that the opening ever will become closed completely by bone unless it is very small.

A permanent opening in the skull does not in itself give rise to any symptoms, although the patient may complain of a sense of insecurity. In many cases, however, patients with gaps in the skull do get severe symptoms, such as giddiness on stooping, fits, headaches, and other sequelæ ; these are probably not due to the actual opening in the skull but are caused by adhesions between the dura and the brain, by thickened dura, subdural cysts or lesions of the cortex, etc.

Fissured Fractures. A fissured fracture is one in which there is no displacement of the fragments, and this condition may be caused by direct or indirect violence, usually resulting from a fall or a blow from a blunt object. These fissures may extend far and wide from the point struck, may implicate one or both tables, and not infrequently run down into the base. Such a simple fissure usually cannot be diagnosed with certainty unless it is accompanied by symptoms of intracranial injury. It will have over it, of course, a superficial extravasation of blood. When compound, however, it can be seen as a crack in the bone, from which blood is oozing, and it may be felt with the finger or probe. A normal suture is sometimes mistaken under these circumstances for a fissured fracture, but the suture should be recognised by its situation, its irregular, serpiginous shape, and the fact that it is not bleeding. Fissured fractures sometimes will enter a suture, run in it for some distance, and then pass out of it again, while in children the normal sutures are sometimes opened or " sprung " as the result of injuries. In some cases cuts in the periosteum will give rise to a ridge which, when felt with the probe, may resemble a fissure. A peculiar " cracked-pot " sound is sometimes present on percussion in the case of an extensive fissured fracture of the vault of the skull.

Although any form of intracranial injury may be a concomitant of a fissured fracture, the forms most commonly associated with this type of fracture are concussion, meningeal hæmorrhage (extradural hæmorrhage) and laceration of venous sinuses.

The *treatment* of a fissured fracture when compound consists in the preservation of asepsis by excision and careful cleaning of the wound of the scalp, which should be loosely sutured or drained for forty-eight hours. The fracture itself will require no special treatment, provided one can feel certain that there is no depression of fragments and no injury to structures inside the skull. Intracranial complications, if they arise, must be treated on the lines described in Chapter I. Occasionally such a fracture in its repair may give rise to an excessive formation of callus or an irregularity on the inner aspect of the skull, while the dura mater may become thickened or adherent to the cerebrum or a subdural cyst may form. These lesions will give rise weeks or months after the injury to various symptoms, such as headache, Jacksonian epilepsy, or insanity (see p. 26). In many cases of fissured fracture it is very difficult to be certain that no fragments of the inner table are detached or depressed (an X-ray photograph probably will help here), and in that case, especially on account of the liability of such an injury to be followed some time later by one of the above sequelæ, it is advisable to explore the fracture, remove a portion of the bone and examine the dura, if any doubt exists.

Depressed Fractures of the Vault. These fractures are due to direct violence from falls or blows : they, of course, may be either simple or compound, and are usually comminuted. When they are produced by a penetrating injury with a comparatively sharp instrument they are known as "*punctured fractures.*" In this latter case the fracture is always compound, the risks of infection are present, and fragments of bone are not infrequently driven right into the brain, the dura being lacerated. The terms "*gutter fracture*" and "*pond fracture*" are used for different forms of depressed fracture, according to the shape of the depression, the pond fracture consisting of a gradual, gently-sloping depression, while the gutter type has at any rate at one part a much more sharp and abrupt dip, which renders it more serious. It is possible for the outer table to be fractured and depressed without the inner table being injured (this being especially seen where there is an air cavity in the bone or where the diploë is particularly thick), but in nearly all cases the whole thickness of the skull is involved, the inner table being the more extensively damaged. In children depressed fractures may have rather different features, for here the bone is frequently indented without being actually fractured, this being the truest example of a pond fracture, and analogous to a green-stick fracture in other bones, while it is practically only in children that we find the inner table broken without the outer. It must not be forgotten that when a fracture is caused by the exit wound of a bullet which has traversed the skull, the reverse holds good and the inner table is less extensively damaged than the outer. The signs and symptoms will depend largely upon the shape and extent of the fracture, upon whether it is simple or compound, and upon what additional injuries are produced to the intracranial structures. Though any of the forms of intracranial damage may coexist with such a local depressed fracture, it is found that damage to the brain and injuries to the structures within the skull are less common, less serious and less extensive than in such forms of cranial injuries as fractured base. Concussion is nearly always present, and the dura under the injured portion of the skull is not infrequently torn, while there may be a certain amount of local laceration of the cerebrum, but diffused injuries throughout the brain substance, severe intra- or extra-

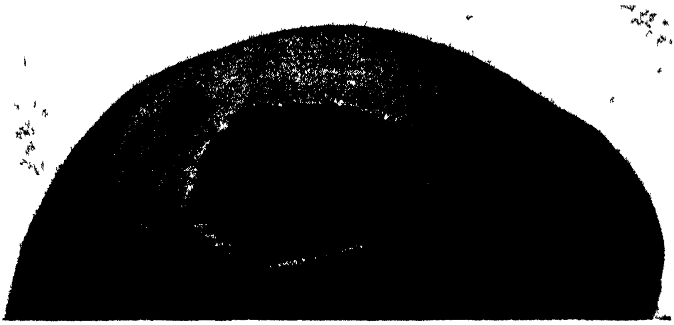

FIG. 16. Depressed fracture of the skull

dural hæmorrhage, and any marked degree of cerebral compression (see p. 14) are not frequently associated with these localised depressed fractures.

(*a*) A *simple depressed fracture* will be covered almost always by a large hæmatoma, which may render it difficult to feel the fracture, but firm pressure over the injured spot will enable the depression to be felt, while, on the other hand, it must not be forgotten that simple hæmatomata of the scalp not infrequently resemble depressed fractures (see p. 56). Symptoms of cerebral compression may be present occasionally, the compression probably being due more to extravasation of blood and œdema than to the actual depressed fragments, but these symptoms are not usually marked, nor are they very generalised, and in most cases the patient will recover; although if the depression is left unrelieved it is likely that there will be various unpleasant sequelæ in the future, such as chronic headaches, insanity, traumatic epilepsy or various forms of spasm or paralysis. When compound, a skull fracture is more easily diagnosed, and it must be remembered that *it is exceedingly rare to meet with a depressed fracture which is not compound*, even in children.

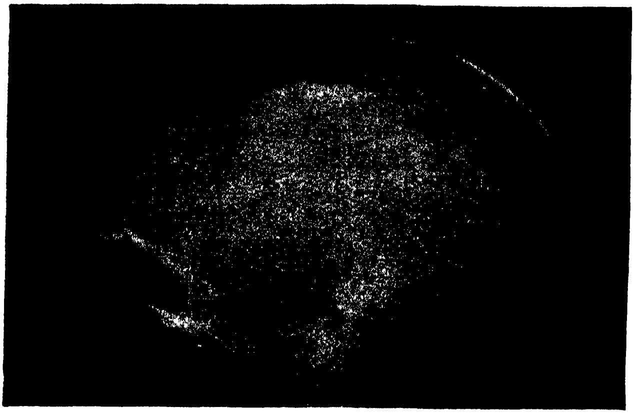

FIG. 17. Depressed fracture of the skull in a child.

(*b*) In the case of a *compound depressed fracture* of the skull, the immediate symptoms are often surprisingly slight, as there may be no concussion even though the dura is torn and brain matter protruding. This is probably explained by the fact that the blow is largely expended in fracturing the skull and less force is employed in damaging the brain. There may be profuse external bleeding, but there is not likely to be any marked degree of cerebral compression. In some instances cerebrospinal fluid or brain substance will flow out of the wound, this showing that the dura mater is torn. If the wound in the scalp is big and ragged, as will be the case after blows with blunt instruments or falls on the head, the fracture usually can be both seen and felt easily, but where it has been caused by a blow with a sharp instrument the external wound may be small and the fracture in the skull will not necessarily be underneath it if the blow has been struck obliquely. In this case it may be difficult to see or feel the fracture, and it will be found not infrequently that foreign bodies are left in the valvular wound so formed; thus cases will be seen where a proper examination can only be made by enlarging the scalp wound. It must not be forgotten that in all severe depressed fractures of the vault it is quite likely that large fissures will run down towards the base of the skull. Compound fractures of the skull are almost certain to become infected if not properly treated, and the bone, the meninges or the cerebral substance will then become inflamed. In the first instance there will be a septic osteomyelitis of the skull, which may spread for a considerable distance and give rise to extensive necrosis, while, on account of the exceedingly large vascular spaces in the diploë, the onset of pyæmia or the formation of an extradural abscess (see p. 30) is not uncommon. If the dura mater is torn there always will be a liability to septic meningitis, infective encephalitis—either localised or diffuse—or a cerebral abscess, and these complications will supervene occasionally even when the dura mater has not been torn by the injury; for it may become ulcerated by the pressure of sharp, spiky, bony fragments, while in other instances infection appears able to pass through to its inner surface without any visible damage to the membrane itself. Any of these forms of intracranial infection are likely to spread much further and be much more serious if there is only a small wound and the depressed fragments of bone are closely fitted together than if there is a large wound and free external drainage. Once the brain matter itself is infected, a hernia cerebri is very likely to follow. The prognosis as to ultimate recovery depends almost entirely on the extent of any associated intracranial injury, and on how successful treatment is in preventing the onset of infection, a fractured vault which is not complicated by brain lesions or by infection being of no great danger.

Treatment. The main objects of treatment in all cases of fracture of the vault of the skull are, firstly, to prevent the onset of infection; secondly, to restore the outline of the skull and do away with the possibility of any fragments of bone, or the callus that they ultimately may throw out, pressing upon or irritating the underneath portions of the brain; thirdly, to protect the dura mater from being injured by sharp spikes of bone; and fourthly, to deal with and treat any associated intracranial injuries. Though the principles are the same, the treatment will differ slightly according to whether the fracture is simple or compound, and the most important decision to be made in any case is whether immediate operation is necessary or not. A general rule for guidance on this point may be stated as follows: that operation will be necessary always in a punctured fracture, in a compound fracture, depressed or fissured, or in a simple depressed fracture in an adult, this latter condition being, as we have already stated, exceedingly rare. In a simple depressed fracture in a child operation is not necessarily required. Here, should cerebral symptoms be present, it of course will be necessary, but otherwise unless the fracture is very deeply or very sharply depressed, it is better to treat the condition expectantly, as many cases will elevate themselves in the course of some weeks.

(*a*) *Compound Fractures.* Here operation will be necessary whether cerebral symptoms are present or not, and it should be done as soon as possible. It will be of advantage to have an X-ray picture before the operation, if this can be done without undue delay, as by this means some idea will be obtained as to how badly the bone has been splintered and how deeply the fragments have been driven. With regard to the form of anæsthesia employed, it is quite easy to perform the operation with ether or chloroform, given by any of the ordinary methods, though probably the best and easiest variety for both the surgeon and the anæsthetist is ether administered by an intratracheal catheter. Some surgeons advocate that these operations should be performed under local anæsthesia, which may be combined with avertin. The scalp is first shaved, the wound cleaned with antiseptics and excised, and the bone should then be explored either by one or more radiating linear incisions, as advocated by Cushing or, better, by turning down a flap of adequate size. The bone is then carefully examined and the injured area rendered as aseptic as possible by means of antiseptic solutions. All loose fragments are removed carefully and the edges of the opening in the bone trimmed and made even. If the dura is not opened, and if there are no symptoms of serious intracranial damage, this probably will be all that is necessary, and after the bleeding in the scalp and bone has been stopped by the ordinary methods, the wound can be closed, with or without drainage, according to the circumstances.

If, however, the dura mater has been opened, the edges of the opening should be gently excised, but the opening itself enlarged as little as possible, in order that any adhesions around the opening which are helping to shut off the general subdural space may not be damaged. Gentle irrigation with saline at a temperature of about 105° F. is then employed, and the brain is gently explored with the finger so that any foreign material or fragments of bone and damaged brain tissue may be removed. Some fragments may be removed with forceps, others can be washed out with the saline, while the damaged brain tissue is best removed by suction with a rubber tube and bulb, or other suction apparatus, as this method is less likely to damage uninjured brain tissue. The question as to whether the wound should be drained or not will then arise ; if possible, drainage should not be employed, but the decision must depend upon the circumstances of the case and how great the chances of infection appear to be. The more thorough the operation and complete the cleansing of the tissues, the less necessary will drainage be. It is best therefore, if possible, to close the wound completely with sutures, stitching the scalp flap back in place. It may be difficult to suture the dura, nor is this essential, as a new dural membrane is rapidly formed. Various special methods of controlling hæmorrhage from the brain, the venous sinuses, the dura mater, the bone. and the scalp may have to be employed, and a description of these will be found on p. 89.

It should be remembered that quite small punctured fractures (produced possibly by a knife) require just as thorough an operation as the more extensive breaks.

In many cases, where the injury has been produced by a blunt instrument and the condition is in no sense a punctured fracture, the above procedure can be much simplified, as no question of exploring the dura and brain will arise ; but in gunshot wounds, on the other hand, the operation may be far more complicated, as there may be two wounds and fractures (of entrance and exit), and a much more thorough exploration of the brain probably will be necessary.

After the operation the patient should be returned to bed with the head slightly raised and sulphanilamide or urotropin should be administered ; morphia should be avoided in the after-treatment of head cases. In some cases it will be found that after such an operation cerebral symptoms of more or less severity will persist, and this will indicate that other widespread damage is present within the skull. The intracranial conditions and the complications which often follow compound fractures of the skull, namely, extradural abscess, meningitis, cerebral abscess, and diffuse encephalitis, have been considered in the last chapter ; they must be watched for continually.

(*b*) *Simple Depressed Fractures.* Though it is quite likely that cases of simple depressed fracture in adults will recover without operation, those cases which are not operated on are sure to be left with a depression or irregularity in the skull, which will irritate and press upon the dura, and serious effects are likely to follow this after a lapse of months or years. Moreover, as one can never be certain as to the amount of damage to the bone, the inner table, and the dura until these structures are exposed, and as the risks of the operation performed in the absence of an infected wound are exceedingly small, it is best always to urge operation in every such adult case. It should, however, be remembered that this is not the view of all surgeons, and certain authorities, especially German surgeons, are in favour of a more expectant form of treatment.

Here again, as in the case of the compound fracture, the sooner the operation is performed the better. The scalp is shaved and prepared and the flap is turned down as before, care being taken to avoid making the incision in the skin immediately over the fracture; when this has been done, any blood clot is cleared away and the fracture is exposed. All loose and depressed fragments are gently removed. Sometimes it will be found that this can be done straight away by picking them out with forceps. More often, however, the opening in the bone will have to be enlarged as the fragments are impacted or interlocked. Occasionally this opening can be enlarged with cutting forceps, but usually the best plan is to trephine the skull at the side of the opening, removing a circle of bone so designed that two-thirds of its circumference are on the unfractured skull, and one-third over the fractured portion. Occasionally in the case of a very small fracture it is possible to include the whole fractured portion in one large trephine circle. An elevator is then introduced and passed between the dura and the skull and all depressed and loose fragments of bone removed. The edges of the bony opening are then trimmed and rounded and the dura examined. It is not likely in a simple fracture that the dura will be found to be damaged, and in any case the greatest care must be taken not to open it, either while trephining or picking away the loose fragments. If the dura is uninjured this is all that need be done, and though some surgeons advise that in this case, as the wound is aseptic, the fragments of bone removed should be kept in warm saline and fitted into the aperture in the skull afterwards, this is probably a most unwise proceeding, for it is extremely unlikely that by this means the contour of the skull will ever be exactly reproduced, and a further depression of bony fragments may follow. Moreover, openings in the skull where the dura is uninjured do not appear to give rise to any trouble unless they are very large, and in any case such a skull opening always can be covered in afterwards most satisfactorily by Sargent's method of employing celluloid plates (see p. 28). The scalp therefore should be sutured into place without replacing the bone fragments, and no drainage is required.

If the dura mater is found to be injured, a certain amount of damaged cerebral matter may escape. In this case the dural opening should be slightly enlarged, a careful examination made to see that no fragments of bone are in the brain, and any damaged cerebral tissue should be removed gently by irrigation or suction. The dura mater is then as far as possible brought together and the flap replaced without drainage.

The most likely complications to be met with at the time of these operations are various forms of hæmorrhage, either extradural (middle meningeal), subdural or, occasionally, free bleeding from a venous sinus. The first two of these will give rise to characteristic symptoms which, with their treatment, are described in Chapter I., while the special methods required to control hæmorrhage from a venous sinus are also described there. In those cases where the fracture is simple the liability to infective complications afterwards is exceedingly small. The after-treatment should be the same as that described on p. 71, and, above all, it must be remembered that every case of severe skull or head injury must receive a prolonged period of rest afterwards.

Treatment of Fractured Skull in Children. The treatment of a compound fracture of the skull in a child is the same as that described above, but in the case of the child's simple depressed fracture, it is quite likely that the fragments in the course of a few weeks will elevate themselves, and unless, therefore, the fracture is very sharply or deeply depressed, or unless intracranial symptoms are present, no immediate operation will be required.

If operation does become necessary in the case of a simple depressed fracture in a child, owing to the depression showing no signs of bulging up after a week or two, or because the depression is very deep or sharply depressed, a flap should be turned down in the ordinary way, but in this instance there is no need to remove the depressed fragments. These can be elevated best by making a small trephine opening just to one side of the fracture and inserting an elevator between the bone and the dura, when it will be found that the skull of the infant is so soft that the depression can be moulded back into shape without removing any fragments. It must be remembered that the skull of the child is very thin and soft.

Traumatic Cephalhydrocele. This is a rare complication that may follow any form of simple fracture of the vault of the skull in a child. The fracture is usually not followed by any severe symptoms, but in the course of a few days or a week or two afterwards, when the hæmatoma is beginning to subside, a localised soft fluid swelling slowly appears beneath the scalp. This swelling is painless, and may vary in size from day to day and be reducible on pressure, while it frequently has an impulse when the child coughs or strains, and may occasionally pulsate with the heart beat. The swelling may be under the pericranium, but more commonly this is torn and the collection lies in the subaponeurotic layer; the fluid which it contains is cerebrospinal fluid, which has escaped through a crack in the bone and a tear in the dura underneath to form a collection outside the skull communicating with the subdural space. The fluid swelling is usually particularly flaccid and soft, and no signs of solidification or clotting appear round its edges. Rare cases have been described in which the brain substance has also been lacerated, and the swelling may then communicate with one of the ventricles of the brain. It is most commonly associated with a fissured fracture in the bone, but rarely a distinct round opening in the skull

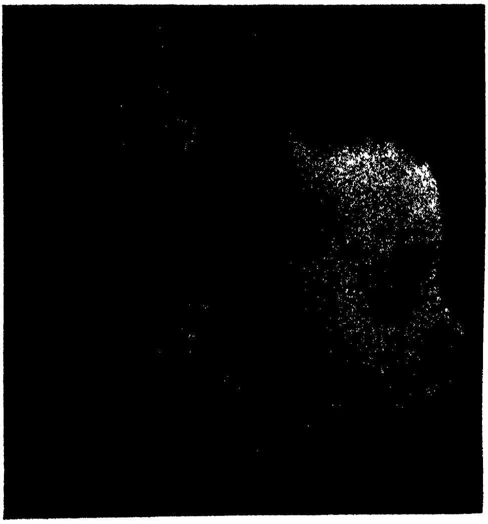
FIG. 18. Traumatic cephalhydrocele.

may be felt. The condition does not as a rule require any active treatment, and is best left alone, though it is not likely that it will undergo spontaneous cure. If treatment seems urgently necessary the cyst must be explored, the opening in the dura discovered and sutured, and the hole in the bone closed, if necessary, with a bone graft.

FRACTURES OF THE BASE OF THE SKULL

These are more common than fractures of the vault and are almost always fissures running more or less transversely or longitudinally across the base of the skull, though very occasionally punctured or depressed fractures will occur, where sharp objects, such as pipes, umbrellas, foils, knitting needles, etc., have violently impinged upon the bone through the nose, pharynx or orbit. In these latter cases one part or other of the anterior fossa will be injured, while in other instances the condyle of the jaw has been forced through the glenoid cavity (by a blow on the chin) into the middle fossa. Gunshot wounds in the mouth also will penetrate the base of the skull, while injuries or stabs in the occipital region may do so likewise. Heavy falls upon the body, buttock or feet, upon comparatively soft objects, will cause such an impact of the vertebral column against the occipital portion of the skull, that fissures radiating from the foramen magnum may be caused, while occasionally a complete ring fissure around this foramen has been described. These are all fractures due to direct violence, but by far the greater majority of fissured fractures of the base (the only type that is common) are caused by indirect violence, the accident nearly always consisting in a fall upon the head from a height or else in a heavy blunt body descending upon the skull. The problem of the way in which a blow on the vertex produces a fissured fracture running across the base can be solved by noting certain anatomical features in the shape and structure of the skull. Many parts of the base are on transillumination obviously thin and weak, such as the anterior and cerebellar fossæ, while in some situations portions of the bone which appear to be thick and strong really are much weakened by containing large air spaces and sinuses. Stronger buttresses and ridges run across the base in many situations, and these conduct the forces and violence applied to the vault down to the base.

The vertex of the skull is elastic and strong, the bone being firm, continuous, and not weakened by holes or foramina in it. On the other hand, the base of the skull is thin, rigid and inelastic, the bone itself is not strong, and it is considerably weakened by a multitude of foramina and thin plates, while in addition this more or less closed box contains what is virtually an incompressible fluid. A heavy blow on the vertex thus will produce an instantaneous small amount of deformity of the skull, which takes the form of compression along some axis, and is accompanied by a great instantaneous rise of intracranial pressure, with the result that there must be a corresponding bulging or elongation along some other approximately opposite axis ; in this way some part of the bone weaker than the original spot struck may give way, and the weakest and least elastic part is undoubtedly the base. This is really a fracture by bursting, and it is found roughly that the direction of the basal fissures are those of the forces which produce them, although a crack at the base of the skull may be of a complicated shape, owing to its tendency to run through various normal fissures and apertures and to give rise to multiple branches. Thus, if the skull is compressed by a blow from side to side, the fracture in the base is often transverse, while if the blow is antero-posterior, the fissure is more often longitudinal. Such a fissure nearly always will run into and involve any foramen which is near to its line, and in this way small portions of the bone may be completely detached. There is another theory which attempts to explain the production of these fissured fractures, and this states that such a fracture of the base is always due to direct extension of a fissure commencing at the point struck. This theory of "irradiation of fissures" is attributed to Aran, and though it is undoubtedly true in a few cases, it certainly does not explain all basal fractures. In addition to their tendency to pass through foramina, such fissures often will follow a natural suture in the skull, but they appear to be surprisingly capricious, and it is not unusual to see even the dense petrous portion of the temporal bone cracked across. Sometimes only one fossa of the skull is involved, and this is naturally more likely to be the case if the fissure is transverse, but it is more common for two or even all three fossæ to be implicated.

Fractures of the base may be simple or compound. The compound form is by far the more common, for a fissure in the anterior fossa almost necessarily extends across the cribriform plate and tears the nasal mucous membrane, or that of the ethmoidal or sphenoidal sinuses, and thus the fracture communicates with the open air. In the middle fossa also a fracture is almost certain to involve the roof of the naso-pharynx, the tympanic cavity or the external auditory meatus, and in these cases again it will be compound. Thus it is only in the posterior fossa that there is any likelihood of a fracture being simple, and even here, if the basi-occipital bone is cracked, the nasal pharynx may also be involved. A fracture of the base of the skull is a most serious condition, partly owing to the fact that it is commonly compound, but chiefly owing to the grave intracranial damage which generally accompanies it. The dura mater is sometimes torn also, and this places the subdural space at the base of the brain in immediate communication with a septic cavity, such as the nose, pharynx or ear. The liability to meningitis, therefore, is always present, but in addition to this, although fractures of the base may be accompanied by any form of intracranial damage, they are usually accompanied by the more serious and dangerous varieties. This is due to the fact that the injury is usually a violent one, that none of this violence is used up in producing a local fracture of the skull, while owing to the instantaneous and great rise

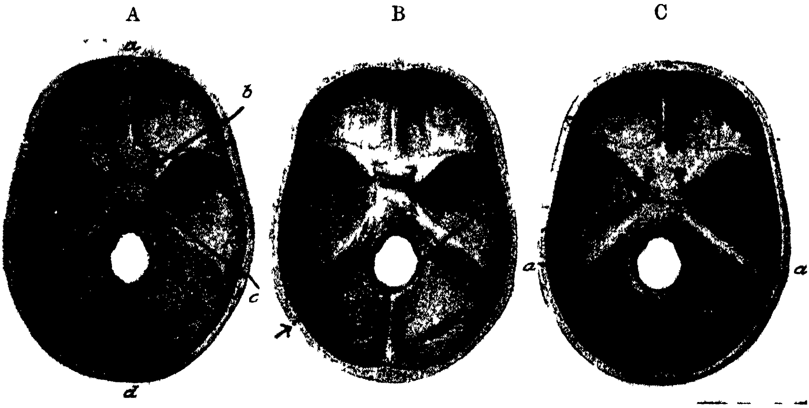

FIG. 19. Diagram of the way in which fissured fractures of the base are caused. (A) Shows the direction of various forces acting on the skull *a*, *b*, *c*, *d*. (B) and (C) are ordinary forms of fractured base.

of pressure produced within the skull, violent strains and stresses act upon every part of the semi-fluid intracranial structures. Thus severe contusion and laceration of the brain, severe hæmorrhages, both subdural and extradural, from arteries, veins or sinuses, and extensive damage to the base of the brain, more especially to the all-important pons and medulla, are common, while the associated concussion is usually severe. In addition to this, inasmuch as the foramina at the base of the skull are so often involved, the cranial nerves are particularly liable to injury, either at once, as the result of being bruised or torn, within a few hours because of hæmorrhage into their sheaths, or after some weeks or months, when they may become surrounded or pressed upon by the callus that is formed in the process of repair.

It must be remembered that none of the ordinary signs of a fracture are here present, and that in many cases no signs pointing directly to damage to the skull can be elicited at all ; thus the diagnosis will have to be inferred from certain associated conditions. The most important of these are (*a*) the signs of severe cerebral damage, for which see pp. 11–25.

(*b*) Various hæmorrhages, either externally from the nose, mouth or ears, or subcutaneously under the scalp or into the eyelids and orbit.

(*c*) The discharge of cerebrospinal fluid from the nose, ear or mouth. This can be recognised as a clear fluid of low specific gravity (1003), which does not clot or coagulate on boiling and which reduces Fehling's solution owing to the presence of glucose.

(*d*) Rarely, escape of brain matter from any of these situations.

(*e*) Damage to various intracranial nerves, which pass out through the base of the skull (see Vol. I., Ch. XII.). The nerves most commonly affected in this way are the seventh and eighth, but no cranial nerve can be regarded as being immune.

It is usual to consider these fractures of the skull according to which fossa is chiefly involved, though it must be remembered that more than one fossa is frequently implicated.

Fracture of the Anterior Fossa. This fossa is usually fractured either as an extension of a fissure on the vertex of the skull or else from severe blows on the forehead and nose ; more rarely it is due to punctured wounds of the orbit and nasal cavities. There is usually severe concussion, but this is not necessarily present, and, as a rule, the intracranial damage associated with fractures of this fossa tends to be less severe than it is in the case of the other fossæ. As already stated, the fracture is very nearly always compound and the cribriform plate of the ethmoid or the orbital plates of the frontal bone are involved, so that in this case there may be severe hæmorrhage into the nose or naso-pharynx. When this occurs it is quite likely that a great portion of the blood will be swallowed and be vomited later on, while profuse epistaxis is likely to occur.

In some cases this hæmorrhage into the nose or mouth is partly due to laceration of the nasal mucous membrane, in other cases it comes from the bone itself, but in some, and especially when it is severe, it may be due to damage to the vessels and venous sinuses within the skull. If the dura mater is torn (especially the prolongation along the olfactory nerves), cerebrospinal fluid also will escape into the mouth or nose, and it will not be easy for the surgeon to recognise this when it is mixed with blood, but the patient may call attention to it by complaining of a persistent salt taste, as this fluid contains a high percentage of sodium chloride. Cases have been described in which, owing to very severe injuries, brain matter has escaped into the nose or pharynx. In other instances, where the line of the fracture runs across the roof of one or both orbits, a prominent feature will be the extravasation of blood into the orbits. This may become visible in the course of some hours, appearing first under the conjunctiva at the outer angle of the eye and passing forwards from behind, almost to the cornea. Later on the blood spreads into the lower and even the upper eyelids, giving rise to an intense subcutaneous, bluish-purple discoloration, with some swelling of the lid itself, some proptosis of the eyeball, and occasionally a squint due to interference with the ocular muscles. This will resemble closely the ordinary "black eye" following a blow, but it may be distinguished from this by observing that there is no bruising of the skin, that the colour is dark purple from the first, instead of being reddish as in the "black eye," that the conjunctiva is extensively involved, that the posterior limit of the effusion cannot be seen, that the effusion commences in one lid before the other (affecting the lower lid first), that it does not come on for some hours after the injury, and that in the case of the fractured base it is most common for both orbits to be involved. Occasionally in very severe cases, where the cavernous sinus or some big vessel is involved, in addition to the proptosis, there will be pulsation, and in this case a traumatic aneurysm or arterio-venous aneurysm is forming. If the frontal sinus is involved in the fracture line, air will escape under the scalp and give rise to surgical emphysema, especially after sneezing or coughing (see Vol. I., Ch. VII.).

If there is an extrusion of brain matter in this fracture, it will occur into the nose. This implies great laceration of the bones and membranes and is very rare.

In the case of the anterior fossa, the cranial nerves most likely to be involved are the first, second, third, fourth, sixth and the upper division of the fifth.

It must be remembered that bleeding from the nose or mouth or extensive "black eye" often will follow blows upon the head or face without there being necessarily any fracture of the base of the skull, while at other times these conditions will occur also in the absence of a fractured base when they are associated with a small fracture of the orbital ridge or of the malar bone.

Fracture of the Middle Fossa. This is a common form of fracture and usually seen after severe falls or blows on the head. It is generally associated with very severe intracranial lesions, and in its most characteristic form it passes across the tympanic cavity and tears the tympanic membrane on one or both sides. In this fracture also blood sometimes will escape into the nose and mouth, for the sphenoidal region is often involved, and the cavernous sinus or internal carotid arteries are liable to injury, but the most characteristic sign of this injury is a steady flow of dark-coloured blood from the ear, and this may be accompanied or followed by an escape of cerebrospinal fluid from the meatus. Sometimes this bleeding is very severe, and in this case it probably comes from the posterior branch of the middle meningeal artery. This bleeding may go on for some days, but if cerebrospinal fluid is escaping also, the fluid usually will continue to drain away for a long time after the blood has ceased, and it may be so profuse as to saturate the dressings and pillow. If blood and cerebrospinal fluid are escaping from the ear in the case of a fractured base, it necessarily implies that the drum of the ear is ruptured, but very rare cases have been described in which the drum has remained intact and the blood and fluid have escaped down the Eustachian canal into the throat. It must be remembered that blood (but not cerebrospinal fluid) will escape from the ear in other conditions besides fractured base; thus it may have flowed into the meatus previously from a scalp wound, or be escaping from a laceration or fracture of the external auditory meatus, a simple rupture of the drum, or from granulations in chronic middle-ear disease with perforation. In most of these conditions, however, the blood is bright red and the flow of short duration, while the state of the tympanic membrane and the external auditory meatus can be discovered at once by examination of the ear with a speculum. The flow of blood in the case of a fractured base is dark-coloured, continuous and persistent. Escape of cerebro-spinal fluid from the ear is not common, and when it occurs it probably has found its way into the tympanic cavity through a tear in the dura mater where it is prolonged outwards along the auditory nerve in the internal meatus. Escape of brain matter from the ear is very uncommon.

The cranial nerves most commonly involved in a fracture of the middle fossa are the sixth, seventh and eighth, and the second and third divisions of the fifth. Thus deafness is a not uncommon accompaniment of a fracture across the middle fossa, but it must be remembered that though in some cases it is due to tearing of, hæmorrhage round, or the pressure of callus upon the eighth nerve, in others it is due to actual damage to the labyrinth, which may be involved in the fracture line. The prognosis of these cases of deafness is very bad. In nearly every case there will be diminution of hearing due to the rupture of the drum. Surgical emphysema of the scalp is sometimes seen around and behind the ear in this fracture, and it is then due to the escape of air owing to the fracture having passed across the mastoid antrum or air cells; when this occurs it will be found sometimes that the air, instead of spreading under the tissues, becomes localised into a resonant swelling under the periosteum (pneumatocele).

Fracture of the Posterior Fossa. This is usually due to the same forms of violence that cause fracture of the middle fossa, and differs from the other forms of fractured base in that it is very rarely compound, so that it therefore follows that there is rarely any external hæmorrhage; bleeding into the naso-pharynx will occur, however, occasionally when the fracture crosses the anterior part of the fossa. Thus there is as a rule no immediate evidence on which such a fracture can be diagnosed. The patient is, however, usually deeply unconscious, and as the severe associated intracranial lesions are liable to involve the pons or medulla, death frequently supervenes rapidly. Subtentorial hæmorrhages also occur, and give rise to severe or fatal bulbar compression. Should the patient live, in the course of two or

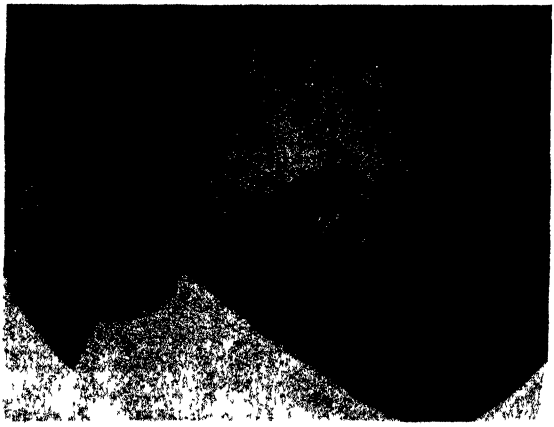

FIG. 20. A fractured base involving the posterior fossa. The picture shows the characteristic head retraction, and the subcutaneous ecchymosis appearing after a short time below and behind the mastoid process.

three days the blood extravasated from the fracture finds its way to the surface and gives rise to subcutaneous bruising and ecchymosis, at the back of the mastoid process or further down the neck. Escape of cerebrospinal fluid and brain matter does not occur, while the cranial nerves which are liable to be injured are the ninth, tenth, and eleventh. Not infrequently a fracture of the posterior fossa runs also across the petrous portion of the temporal bone, and in this way the seventh and eighth nerves may be damaged. The twelfth nerve almost invariably escapes, but it will be found sometimes that the upper cervical nerves are irritated by blood clot, and this will lead to retraction of the head and stiffness of the cervical muscles.

Thus it will be seen that in many cases the diagnosis of a fractured base has to be made upon such indirect or presumptive evidence as is furnished by hæmorrhage, escape of cerebrospinal fluid, and associated injury to the cranial nerves and the intracranial contents. In connection with the latter it should be noted that those which are usually associated with a fractured base are not only severe, but are generalised and show little signs of localisation, and in this case the presence of blood in the fluid withdrawn on lumbar puncture may afford useful evidence as to the nature and situation of the cerebral damage. In many cases which recover the diagnosis of a fractured base is really little more than a conjecture, but it is most important that when this presumption is made, it should be acted upon and the case treated as if it were a fractured base.

Prognosis. The prognosis in the case of a fractured base depends almost entirely upon the nature of the cerebral injuries associated with it and upon the occurrence later of complications due to infection, such as meningitis, encephalitis, or cerebral abscess. These latter complications are surprisingly rare, but the association of serious cerebral injury with the fracture is almost universal. It will be found that many cases die within a few hours from cerebral compression due to œdema or hæmorrhage, and if from the first the coma appears to be deepening, and the pulse either to be rising steadily or falling, the prognosis is bad. If the patient survives for two days the prognosis becomes hopeful, and in this case the temperature chart is often a useful guide. It will be found that nearly all cases have a rise of temperature due to the intracranial conditions, and if this rise is steady and rapid the prognosis is very bad; if it steadily descends and becomes subnormal it is equally bad; while if there is a moderate rise of temperature to, say, 101° or 102°, and then a return to the normal, the prognosis is good (see Chapter I.). A free escape of blood externally may relieve the pressure, and possibly, therefore, renders the prognosis better. Once the danger of cerebral complications is over, union of the fracture occurs rapidly and completely, though there may ensue troublesome sequelæ owing to important vessels and nerves being involved by scar tissue or callus.

Treatment. The first and most important treatment to be adopted is to prevent infection occurring through any site where mucous membranes are torn. In the case of the pharynx and nose this is difficult, and it is not wise to employ douches or mouth washes, nor would it be easy to do so in a comatose patient. Luckily the naso-pharynx is frequently sterile, and the dura mater is seldom torn, so that the onset of meningitis is not common. In those cases where the ear is involved in the fracture it is better not to syringe or wash it out, but it should be gently sponged dry with sterile wool and the meatus plugged with sterile gauze moistened with a weak antiseptic solution, and this dressing will have to be changed frequently if there is a free flow of blood or cerebrospinal fluid. In most instances the hæmorrhage from the nose or ear will cease after a few hours ; in the case of the nose, if it is very severe, it probably comes from a laceration of the internal carotid, and when this is so death is usually so rapid that nothing can be done. If the aural bleeding does not cease in a few hours, it probably comes from the middle meningeal vessel (posterior branch), and in this case it is not wise to plug the meatus, as this may increase intracranial tension ; but an operation must be undertaken to tie the vessel and control the hæmorrhage. Hæmorrhages into the orbits and lids, which may be very severe, ultimately will absorb and disappear if the patient lives. Cerebrospinal leakage always will cease of itself. If there is a discharge of brain matter, this should be gently wiped away, and the case is even then not hopeless. Urotropin, in doses of 10 grains three times a day, should be given to all cases of head injury, as it is said to diminish the liability to infection in the meninges. The treatment otherwise is entirely that of the associated head injuries. If compression of the brain appears to be severe, relief is occasionally afforded by the diminution of intracranial pressure produced either by injections of hypertonic saline, by lumbar puncture or by means of a decompression operation ; this latter procedure is, however, very rarely necessary in the case of a fractured base (see p. 88). The patient may be allowed to sit up in bed and have his diet gradually increased about a week after all symptoms of the intracranial lesions have disappeared, and another week should elapse before he is allowed to get up ; even in the mildest cases he should not return to work for at least two months.

BIRTH FRACTURES

Fractures of the skull produced (usually by the forceps) during the birth of a child are rare. Depressed fractures are occasionally seen in the fronto-parietal region ; at first they are often obscured by a hæmatoma, but after a few days the blood will be absorbed and they can be palpated. In many cases the skull is so soft that it is depressed without any actual fracture or fissuring As a rule such a fracture produces no cerebral symptoms, though it may be accompanied by various forms of intracranial hæmorrhage (see p. 21) which will cause symptoms. The brain of an infant seems to tolerate a considerable amount of compression, but in extensive fractures fits and convulsions will occur, especially when there is a marked depression over the motor area.

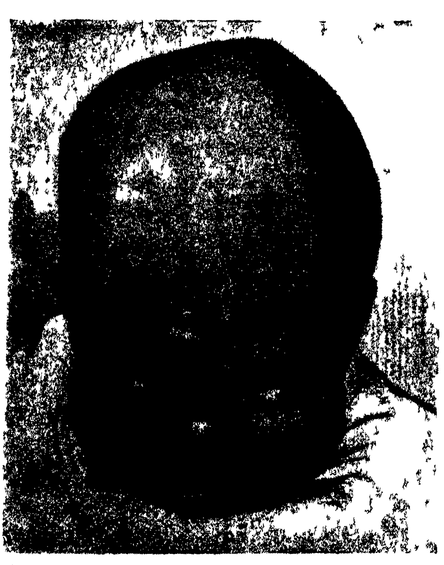
FIG. 21. Depressed fracture in an infant as the result of birth injury.

Treatment. Slight dents and depressions, especially if they are over a silent area, may be left without operation, as they will rectify themselves probably in the course of a week or two. But extensive depressions, especially those which are associated with cerebral symptoms or which are over the motor area, should be treated by operation as soon as convenient (see p. 70).

Fissured fractures are sometimes seen in infants, occasionally as the result of birth injuries, but more often as the result of blows or falls a few weeks later. Their symptoms and treatment are the same as in the adult, but in one respect they differ very greatly. The infant's brain is increasing in size so rapidly that there is a distinct tendency for the fissure, instead of uniting, to become wider and for its edges to be forced apart and everted. This is still more likely to occur if at the time of the injury the dura mater is torn and there is some rise of intracranial pressure. When this occurs cerebrospinal fluid and even brain matter may be forced out through the opening in the bone and form a swelling under the scalp, known as a **traumatic cephalocele** (see p. 73). The condition is not likely to be recognised until the hæmatoma is absorbing some days after the injury, when a wide gap will be felt, with a soft, reducible pulsating swelling protruding. In some cases where no brain matter protrudes the condition gives rise to a traumatic cephalhydrocele (see p. 73).

Treatment. If such a fissured fracture appears to be increasing in width, it may be necessary to turn down a flap and suture the bones together.

The treatment of a traumatic cephalocele is the same as that of a congenital one (see p. 83).

CONGENITAL CONDITIONS OF THE SKULL

An incomplete ossification of the bones of the skull is occasionally seen in babies born of a mother who is in a poor state of general health or who is wasted. The condition is known as **congenital aplasia cranii,** and causes the bones to be soft and membranous and to remain so for a long time. The condition sometimes persists throughout life, in which case minor injuries, which would have very little effect upon a normal skull, may prove a serious risk to the patient. No treatment has any effect on the disease.

Cephaloceles. A cephalocele is a protrusion of a portion of the dura mater with or without some of its contents through an abnormal and congenital opening in the bony wall of the skull. The condition is thought to be due to a portion of the primary cerebral vesicle remaining outside the mesoblastic embryonic tissues, in which the skull bones are ultimately formed, so that part of the brain or its membranes remains extracranial. Such a condition is often accompanied by a minor degree of internal hydrocephalus, and in many cases this causes a rise of intracranial pressure which plays a large part in the formation of the cephalocele. A cephalocele is covered by normal scalp, although when the protrusion is large the skin may become adherent to the swelling below, and often be markedly thinned; the condition is only met with in certain situations, the most common site being the occipital region and the root of the nose. In the occipital region these are sometimes high up (supra-occipital type) and extend

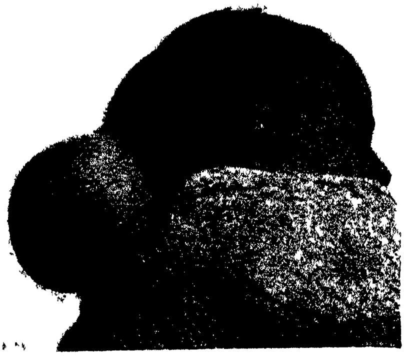
FIG. 22. Large meningocele.

into the posterior fontanelle, while others are low down (infra-occipital) and may reach the foramen magnum and be accompanied by a cervical spina bifida (see p. 112). The frontal varieties may be subdivided into the nasal, the naso-frontal, and the naso-ethmoidal types, according to their exact situation. The occipital ones are usually far the largest. Cephaloceles are also sometimes seen at the anterior inferior angle of the parietal bone, and occasionally at the anterior fontanelle. Very rare instances have been described at the base of the skull, in which case the protrusion may project into the pharynx or nose, and in this situation such a condition has been mistaken for a pharyngeal tumour or a polyp. Cephaloceles may vary in size from a swelling the size of a pea to one bigger than the child's head, which may be incompatible with life or even give rise to difficulty in delivery. They are seen in three varieties, described according to their contents :—

1. *Meningocele*, which is a protrusion of the membranes, containing nothing but cerebrospinal fluid.

2. *Encephalocele*, where the protrusion of membranes contains brain substance in addition to cerebrospinal fluid. Occasionally tumours here are found to contain a mixture of solid mesoblastic and neuroblastic tissues, in which case they are teratomata (see Vol. I., Ch. VIII.).

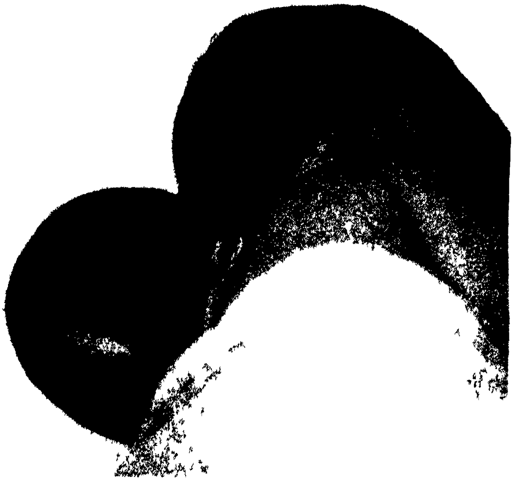

FIG. 23. Large hydro-encephalocele.

3. *Meningo-encephalocele or hydro-encephalocele*, where the membranous protrusion contains an excrescence of cerebral matter which contains within it a part of one of the ventricles, which has been drawn out into it.

(1) The **meningocele** is the commonest form, and is usually seen escaping through the occipital bone between the foramen magnum and the external occipital protuberance. It forms a rounded fluctuating swelling, attached to the skull by more or less of a pedicle, although it is occasionally completely sessile, while it is translucent, diminishes in size on pressure, and varies greatly in tension from time to time. It is covered by smooth, thin skin, in which the vessels are often dilated and nævoid, and does not pulsate with the heart beat, though there is a respiratory impulse; it increases in size and becomes more tense when the child cries, coughs or strains. Gently squeezing the tumour sometimes will give rise to vomiting, slowing

of the pulse or convulsions, and when it is diminished in size by pressure the opening in the bone may be felt. The hair over such a swelling grows normally unless the swelling is very large. It usually will be found that small meningoceles remain stationary, while the larger ones tend to increase in size until the skin becomes atrophied and thinned and ultimately bursts, when death will occur from the escape of cerebrospinal fluid and the onset of meningitis. Many cases which are apparently meningoceles protruding in the occipital region are really hydro-encephaloceles, the fourth ventricle being expanded and protruding, while its thinned-out roof hardly can be separated from the overlying meninges. This may be quite translucent.

(2) The **encephalocele** is less common and is seen most often in the frontal region, where it gives rise to a very similar swelling. The swelling, however, is less easily reduced on pressure, is invariably sessile, is less translucent, and pulsates synchronously with the heart beat as well as with respiration. Pressure upon an encephalocele is more likely to produce convulsions than in the case of a meningocele, while the swelling is firmer and less fluctuant. The encephalocele is often accompanied by spasticity and changes in the reflexes.

(3) The **hydro-encephalocele** or **meningo-encephalocele** is usually very large and associated with a considerable degree of hydrocephalus. It usually occurs in the occipital region, sometimes above the tentorium, when it may contain a protrusion of the posterior cornu of a lateral ventricle. In other instances, when below the tentorium, a portion of the cerebellum lies within the sac. The swelling has in the main the same clinical features as the other types, except that it does not often pulsate, while in many instances it is so large as to be incompatible with life.

All the varieties of cephalocele are very frequently accompanied by other deformities, such as hydrocephalus, spina bifida, talipes and cleft palate.

Cephaloceles may closely resemble dermoid cysts, sebaceous cysts, nævi, cephalhydroceles or cephalhæmatomata. Their reducibility on pressure, their pulsation, either with the heart beat or with respiration, and the fact that the opening in the skull either can be felt or demonstrated in an X-ray film, should serve to distinguish them.

The prognosis of all forms of cephaloceles is bad. Many such infants are born dead or do not live long, while the larger cases are usually associated with idiocy, fits, or hydrocephalus. There is always the possibility that the swelling will increase in size and cause death by bursting. In the case of a pure meningocele in the course of a few years the bony opening, if it is not very large, will sometimes close and convert the condition into a cyst-like swelling fixed to the skull, but shut off from the interior; it will then be irreducible, without pulsation and innocuous.

Treatment. It is only small swellings which are suitable for surgical treatment, and even these should not be touched if they contain brain matter, or when the skin over them is septic or ulcerated. If the swelling and the opening in the skull appear to be small and the tumour is a pure meningocele, it may be excised, the dura at its base sutured, and the bony opening closed with a bone graft. If they are large, they must be protected from irritation and infection, while occasional aspiration with a hollow needle may prevent them increasing in size. The ultimate results of operation are often disappointing, for though the swelling may be cured, the cause of the rise of pressure within the skull persists and frequently leads to hydrocephalus. Aspiration is done by introducing the needle under the skin at some distance from the base of the swelling and then running it along into the sac. The sac should not be emptied completely at first, and gentle pressure is applied with a bandage after each aspiration. It is occasionally found that after several aspirations a case previously regarded as unsuitable may become amenable to operation.

INFLAMMATORY AFFECTIONS OF THE SKULL

The bones of the skull are liable to the same diseases as are seen in the case of other bones, though, owing to the structure of the skull, the pathological changes are not quite the same.

Acute Suppurative Osteitis. This is an acute inflammation of the diploë caused by pyogenic organisms. In its pathology it is very similar to acute osteitis of the long bones, but though it may be the result of an infection brought through the blood stream, as is almost always the case in the long bones, in the skull this is not the most common form, for here it is most usual to find that the disease follows upon an actual breach of the bony surface, which permits the infection to enter the bone. Thus acute osteitis is caused usually by an infected scalp wound, a compound fracture, a syphilitic ulcer, suppuration of the mastoid antrum or frontal sinus (it is seen especially after open operations performed on this sinus), epitheliomatous and rodent ulcers. In persons of low resistance it is sometimes pyæmic, the infection then being blood-borne, and its actual site being sometimes determined by a bruise or blow. It must be remembered that when the infection reaches the skull via the blood stream suppuration occurs both on the inner and outer aspects of the bone. The condition gives rise to separation of the pericranium and extensive necrosis in exactly the same way as it does in the long bones, but in the skull little or no involucrum is formed by the periosteum ; the pericranium is widely stripped up and pus is formed beneath it, and occasionally also between the bone and the dura mater. The extensive necrosis which occurs is limited by the sutures to the particular bone involved.

The disease commences suddenly with a rigor followed by high fever, headache, pain and tenderness, and marked swelling over the bone concerned. This swelling is at first boggy and œdematous, but commences to fluctuate as soon as pus is formed. If there is an infected wound present, its edges become red and swollen and a purulent discharge appears. When suppuration occurs between the bone and the dura mater (**extradural abscess**), a characteristic localised boggy swelling of the overlying area of the scalp occurs. This is due to marked local œdema, and is known as "**Pott's Puffy Tumour.**" When this is seen, it points very definitely to the existence and situation of an extradural abscess. In cases which are treated energetically and early, it is sometimes possible to avoid necrosis, but sequestrum formation usually occurs. In instances where the infection is blood-borne it is usually the whole thickness of the skull which necroses, but in the more common cases due to a local source of infection in the scalp, or in the bone itself, the sequestrum is usually confined to the outer table. Separation of these sequestra takes a very long time and practically no new bone is formed, so that in many instances a complete gap in the skull will be left, which in time will become closed by a dense fibrous membrane more or less fused with the dura mater. General pyæmia, meningitis, sinus thrombosis, cerebral abscess, and septicæmia are liable to occur as complications at any time, for the large venous spaces in the diploë are easily thrombosed and the presence of the emissary veins plays an important part in the production of these conditions; so that the prognosis of the condition, however efficiently it is treated, is always very grave.

Treatment. Early incisions to provide free drainage are essential, and it is wise in all cases to remove the outer table of the affected portion of the bone and lay the diploë open. If the signs point to suppuration under the bone (extradural abscess, see p. 30), the skull must be trephined and the bone cut away to permit of free drainage of the extradural space. After removing all dead bone and pus, the cavity is swabbed out with peroxide of hydrogen and drained, while daily irrigations will be beneficial. A careful watch must be kept for metastatic infections in the joints, other bones, pleura or pericardium (see Vol. I.).

If the patient recovers from the acute stage, sequestrectomy probably will have to be undertaken later on; it often will be found that these sequestra are very difficult to remove, while fresh ones may go on forming for many months.

Chronic Osteoperiostitis of the Skull. This is usually syphilitic, occurring in either the acquired or congenital form of the disease, but it is occasionally simple and the result of a blow or of continued pressure or rubbing, such as may be caused by carrying weights on the head. If painful and liable to ache at night, the newly formed bone, which is usually in the form of a node, should be chiselled away.

FIG. 24. Syphilitic caries of the skull with ulceration of the scalp.

Tuberculosis of the Skull. This condition is not common, and is usually met with in the vault in children, but it occasionally will be encountered in the mastoid process and the malar bone. Though other tuberculous foci probably exist elsewhere in the body, this is usually the only focus in the head, but cases have occasionally been described where it has occurred as a direct spread from either a patch of lupus on the skin or from a meningeal infection underneath. The disease commences in the diploë and gives rise to a characteristic patch of caries, which tends to spread in all directions and often also to form a sequestrum. Extensive granulations are formed between the skull and the dura on one side, and the pericranium on the other side, while cold abscesses will form ultimately on either side of the bone. The outer table is usually less affected than the inner table, and this must be remembered when the question of removing the diseased bone arises.

Clinically the condition appears as a tender localised swelling on the skull, elastic and firm at first, but soon softening and beginning to fluctuate. The skin over the swelling soon becomes red and infiltrated, and in time gives way so that the abscess bursts and multiple sinuses or typical tuberculous ulcers are formed. An X-ray photograph usually will show the disease in the bone, while it will often be found that more than one of these swellings is present. The prognosis is not good unless early operation is undertaken, as the condition is very liable to spread slowly but surely over very extensive portions of the skull, and not infrequently gives rise to infection of the brain and meninges. In many cases it closely resembles a syphilitic caries of the skull, which is much more common, and in all cases therefore, before making a definite diagnosis, it is as well to have the Wassermann reaction tested.

Treatment. The abscess should be opened and all granulation tissue scraped away, any sequestrum removed, and an attempt be made to excise all soft, carious or porous bone with a gouge or forceps. The inner table must be explored carefully, and a large cavity full of tuberculous débris often will be found between the bone and the dura mater, and this must be cleared out. If it is possible to remove all apparently diseased tissue, the wound should be sutured without drainage, and primary union will probably occur. There will necessarily be left a gap in the skull, but this is not likely to require further treatment unless it is very large. The greatest care must be taken in doing this operation not to injure the dura.

Syphilitic Disease of the Skull. Syphilitic affections occurring during the tertiary period of acquired disease and as a result of congenital disease are common in the frontal and parietal bones. They are described in Vol. I., Ch. XVIII.

New Growths of the Skull. The chief tumours found in the skull are osteomata, sarcomata, primary and secondary, and secondary carcinomata.

Osteoma. Both varieties of osteomata are found in the skull: the cancellous type resembles those found elsewhere, and is rare in the skull, occurring only in the lower jaw and in the cartilaginous bones forming the base of the skull, whilst the ivory osteoma is seen only in the skull, where it occurs usually in the neighbourhood of the special sense organs. Bony tumours may grow from either the inner or the outer table, in which case they will project either on the outside or the inside of the skull, and it will be noticed that in the skull they usually arise near centres of ossification. If projecting externally they give rise to a smooth, round, painless, stony hard swelling of very slow growth, and fixed to the bone underneath by a broad base; when growing internally they give rise to symptoms of cerebral irritation or compression. They will be easily visible on an X-ray plate. The ivory osteomata are exceedingly hard, and are especially seen in the external auditory meatus. Occurring as they do in the neighbourhood of the special sense organs, they may cause serious symptoms from interference with these organs, while nerves may suffer as the result of their pressure, and when they occur in or near the frontal sinus the drainage of the space may be interfered with so that infection and pus retention will occur. A further description of osteomata will be found in Ch. VIII., Vol. I.

Treatment. In many cases no treatment is necessary, but if causing unsightliness or symptoms, the tumours should be removed. Small ones can be included in a trephine circle, but large ones may give rise to great difficulties and may necessitate the removal of large pieces of the skull, as they have broad and hard attachments. The ivory osteomata are so hard that they will break the edge of a chisel, and a burr or drill may have to be employed. Ivory osteomata, after being present for many years, exhibit a curious tendency gradually to become loose and detached as the result of a chronic inflammatory process.

Sarcoma. Sarcoma may arise in the periosteum or the diploë, and will be either spindle-celled or round-celled. In many cases nodules of sarcoma, secondary to primary growths elsewhere, will appear in the skull, while in other instances a primary sarcoma of the brain or dura mater will involve the skull by direct infiltration.

A central sarcoma arising in the diploë grows both outwards and inwards, assuming a dumb-bell shape. It grows rapidly and gives rise to a soft pulsating swelling, painless in its early stages, which will ultimately fungate through the skin, while simultaneously it may produce cerebral symptoms owing to its intracranial extension. Such a tumour is sometimes sufficiently rapid in its growth, and is sufficiently soft, hot and painful to be mistaken for an abscess. After fungation has occurred infective intracerebral complications will often set in. The growth is very malignant, metastases are rapidly formed, and the prognosis is very unfavourable.

Osteoclastomata have also been described arising in the diploë. These grow much more slowly and produce more expansion and less destruction of the bone, giving rise often to the sensation of " egg-shell crackling " or " horn-lantern bending."

The pericranial sarcomata give rise to an even bigger and more rapid external swelling, and they tend to undergo partial ossification. Though they ultimately perforate the bone and involve the intracranial structures, this does not occur for some time, but they rapidly give rise to metastases and the prognosis is very bad.

If these growths are small and early, an attempt may be made to eradicate them by removing the portion of the skull concerned, but the outlook even then is very bad, and the operation frequently has to be given up on account of hæmorrhage or the extent of the growth. Radiotherapy is in most cases the only thing that can be done.

Secondary carcinoma in the skull is not uncommon. In most cases this is a metastasis from a distant focus, and it is especially seen after cancers of the thyroid, prostate, testicle and breast. In other instances it is due to the direct extension of an epithelioma on the face or scalp. It usually appears in the form of isolated discrete multiple nodules, which fungate and destroy the skull, but occasionally it is diffused throughout large areas of the skull in the form of a cancerous osteomalacia.

Various forms of **atrophy of the skull** will be met with. **Cranio-tabes** is seen during the first year of life as a result of rickets or congenital syphilis, while senile atrophy occurs in old age, and causes the bones of the vault to become thin and brittle. These conditions are all especially liable to affect the parietal bones, while chronic hydrocephalus is always accompanied by a considerable amount of absorption and atrophy of the whole vault. Thinning of the skull is also seen in **osteogenesis imperfecta** (Vol. I., Ch. XVIII.).

Microcephaly is a condition where the whole size of the cranial cavity is much diminished owing to a non-development of the brain, and it leads to a premature ossification of the sutures. Various forms of idiocy or mental deficiency always accompany this. Attempts have been made to remedy this condition by the operation of linear craniectomy, in which elongated portions of the cranium are removed in the hope that the brain may be enabled to expand. It is highly unlikely that this will do any good, as the primary cause lies in the non-development of the brain, and not in any defect in the development of the skull.

Hypertrophy of the skull may result from many conditions. Many cases are due to chronic inflammation, especially syphilitic (see Vol. I., Ch. XVIII.), to the proximity of cerebral tumours, to rickets (see Vol. I., Ch. XVIII.), to leontiasis ossium (see Vol. I., Ch. XVIII.), to gigantism and acromegaly (see Vol. I., Ch. XVIII.), and to osteitis deformans (see Vol. I., Ch. XVIII.). Those cases where the cranial cavity is encroached upon and diminished are sometimes known as concentric hypertrophy, the other forms being called eccentric. It must not be forgotten that normal skulls vary very greatly in thickness. In all cases where thickening of the skull is due to chronic inflammation it is the two tables which are most affected.

Leontiasis ossium. This is a peculiar hypertrophy of the bones of the upper part of the face, which grow out as rounded bosses, sometimes filling the orbits and giving the patient what is thought to be a leonine appearance. It is probably due to a septic osteitis of the bones as a result of infected air sinuses inside them (see Vol. I., Ch. VIII., and Vol. II., p. 309).

Operations on the Skull. The various operative procedures and methods of opening the skull are described on p. 52, and below.

OPERATIONS UPON THE SKULL AND BRAIN

Methods of Opening the Skull. The various methods of opening the skull employed—and they are many in number—depend partly upon which portion of the skull it is desired to open and partly upon the reason for doing so. Opening the skull will be undertaken for two main classes of case :—

(*a*) Those in which there is some lesion within the skull which it is not likely can be removed or eradicated. In this case the opening of the skull will be made in order to relieve the symptoms due to increased intracranial pressure, and it will consist therefore in removing a large area of bone and opening the dura mater without making any attempt to close the hole in the former or to suture the latter. Such an operation is known as a decompression operation and there is no intention throughout of preserving the bone removed or of replacing it.

(*b*) In the second class of case are those in which it is hoped that a lesion within the skull can be more or less completely removed, and in this case the method of opening the skull employed is usually one by which the portion of bone removed can be replaced to close the opening, an operation on those lines being known as cutting a bone flap in the skull. Fortunately the cases in which the disease can be eradicated are becoming more and more common, though in a few after the bone flap has been cut it will be found that the lesion cannot be removed and a decompression is all that is possible, so that the bone cannot be replaced and the bone flap has to be sacrificed. The cutting of bone flaps is therefore becoming increasingly important.

In all operations upon the skull and brain the use of an intratracheal anæsthetic, if not essential, is of the very greatest help.

(*a*) *Making a Permanent Opening in the Skull.* Except in the case of special situations, such as the cerebellar region, pituitary and the mastoid regions, the making of a decompression opening at any point in the vault of the skull is performed in the same manner. At the spot selected an ample flap is turned down. This flap may have its pedicle in any direction, though it is best for the pedicle to be at its lower end, and the flap should be considerably larger than the area of bone which it is intended to remove : the pedicle may be quite narrow. The scalp flap is turned down to the bone and bleeding is free, it being controlled on the side of the flap either by curved artery forceps or by putting an intestinal clamp across the pedicle, and on the other side by the special flattened artery forceps, which control long areas of the wound edge, devised by Sargent, or other forms of elongated clips. All round the edge of the wound the scalp is detached from the bone for from a quarter to half an inch. A trephine circle of about three-quarters of an inch is then removed near the middle of the portion exposed and the bone freely cut away all round this by means of strong bone forceps and various types of chipping and nibbling forceps. Some surgeons prefer to make the first opening by means of drills or burrs. The cutting away of the bone will be assisted greatly if preliminary saw cuts are made in a criss-cross direction all over the area to be removed and extending down to the diploë. A large area of bone must be removed, as it is a great mistake to make a small decompression opening, but the edge of the bony opening should not come to within one-third of an inch of the scalp incision. Bleeding from the bone is controlled by means of Horsley's bone wax and from the dura mater by underrunning the vessels with stitches. It must not be forgotten in trephining that the thickness of the skull varies enormously in different situations, different patients and different diseases, and it is always uncertain how thick it will be in any case; care must therefore be taken not to injure the dura. Many attempts have been made to devise a mechanical instrument to replace the trephine; burrs and drills have been devised driven by electric motors, by treadles and even by water or air power, while large trephines of three or four inches in diameter have also been recommended. None of these instruments is in universal use, and few of them are regarded as satisfactory except by their inventors. In most cases the dura mater will be opened, as this is essential if the brain is to be explored or if relief of intracranial tension is to be obtained, while at the end of the operation no attempt should be made to suture the dura, as this is usually impossible and a new membrane is rapidly formed; drainage should never be employed. It is not as a rule necessary to ligature vessels in the scalp, as the stitches will control them.

(*b*) *The Cutting of a Bone Flap.* If it is desired to open the skull by cutting the bone in such a way that it can be replaced, the procedure is different. The site is selected and the scalp flap marked out in the same way. It should be of a large size with a narrow pedicle hinging at its lower border. The incision having been made, the flap is not, however, turned down as in the preceding operation, except that it is separated from the bone for about three-quarters of an inch all round the line of the incision. Four or more small holes in the form of a square are then made with a drill followed by a burr and placed at the angles of the square of bone which it is intended to remove. These four holes will then be joined together by cutting the bone through on three sides of the square, the fourth side of the square, that which lies beneath the pedicle of the flap, not being cut completely through as it cannot be reached. The three cuts joining these three trephine holes may be made with an electric circular saw or an ordinary saw or de Martel's electric drill, in which case the sawing must not be carried right through the bone or the dura will be injured. The saw cuts may be finished off with a mallet and chisel, but we do not regard this as a safe proceeding owing to the concussion it may produce. A useful method of making these cuts is to employ a Gigli's wire saw to cut the inner table, and an ordinary saw to cut the outer table, or the whole proceeding may be done with the Gigli's saw. The Gigli's wire saw must be passed from one trephine hole to the other through its guide, the guide being left in position while the sawing is performed, to protect the dura mater and brain. Three sides of the bone square having been cut, the fourth side of the square may be cut through partially with Gigli's saw and is then broken across by turning the scalp and bone flap down together. These saw-cuts should be sloped in such a way as to produce a bevelled edge that the bone when replaced may not tend to fall into the skull. This cutting of a bone flap is a severe procedure, and in some cases it is wise to defer the remainder of the operation till another day. The dura mater is opened and the necessary procedures conducted

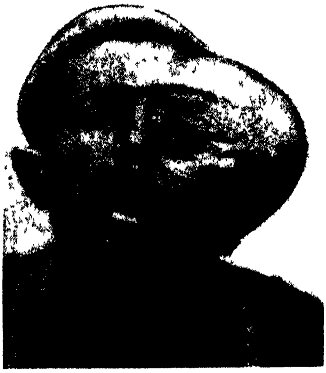

FIG. 25. The result of a badly performed subtemporal decompression. The bone has been removed too far forward so that the bulge has encroached on the face and orbit.

inside. At the end of the operation the skull is closed by replacing the scalp flap and attached bone, though it is wise to remove a small part of the bone in order to leave a small decompression opening. If the lesion inside the skull is such that the bone should not be replaced it may be stripped off the scalp flap before the latter is sutured.

Souttar has introduced a machine for opening the skull which cuts out pieces of bone of circular form of the required size by means of a pivoted lever carrying a lathe tool, the lever revolving upon an expanding mandrel fixed in the skull at the beginning of the operation. It is by no means as easy to use as it appears.

Another method sometimes employed is the use of a small circular saw driven electrically (the skull plough).

All operations upon the skull and brain are best conducted under a more or less continuous stream of warm saline, as it is important to prevent the brain from becoming dry. The brain when exposed may be examined by gentle palpation with the finger, while transparent glass retractors should be employed to press it away from the skull round the opening, so that the brain substance for some little distance can be seen through them. If necessary, incisions may be made into the brain for some depth with a sharp knife to explore the deeper portions. Bleeding from the small veins on the surface of the brain is best controlled either by the application of a muscle graft or underrunning with silk ligatures. For the deeper parts of the brain gentle pressure with gauze soaked in warm saline should be employed.

A suction apparatus will often be of the greatest use.

After operations upon the brain a firm dressing should be put on and the patient nursed with his head slightly raised. Urotropin should be given by the mouth. Morphia is to be avoided studiously, especially in cerebellar cases, as it is liable to cause respiratory failure.

Although they appear to unite strongly, bone flaps do not unite by bony union when replaced. An X-ray film months after replacement shows no signs of bony union having occurred.

Cerebellar Operations. The methods of opening the posterior fossa of the skull and exposing the cerebellum are different and more difficult. Though it is safer to confine the opening in the bone to the area below the lateral sinus, it is possible with care to remove the bone over and above the sinus, too; it is always necessary to remove the bone on both sides of the posterior fossa. The patient is placed on his side with the shoulders raised and his head flexed, while some surgeons employ a semi-prone position, again keeping the head well flexed. An incision is made down the midline of the neck from the external occipital protuberance for four or five inches, while from the same bony point a curved incision is made on either side running out along the superior curved occipital line to the neighbourhood of the base of the mastoid process (Cushing's T incision). The vertical limb of the incision can be dispensed with so that a curved flap is made. Recently these cerebellar exposures have been done by means of (*a*) one long vertical incision, and (*b*) an ⌉-shaped incision. Either of these give an excellent exposure with little bleeding. The incision is deepened down to the bone and the thick groups of muscles detached from the occipital portions of the skull until the base of the skull, the posterior margin of the foramen magnum, and the posterior part of the atlas vertebra are well exposed. These muscles if possible should be detached in two separate layers so that two coverings of soft tissues can be sutured at the end of the operation. In clearing the muscles in the mastoid region, large emissary veins may be encountered and damaged, and the profuse hæmorrhage to which they give rise is best controlled by bone wax. The process of detaching these big groups of nuchal muscles is difficult and liable to give rise to severe hæmorrhage. When the bone is freely exposed the posterior fossa is opened with a small trephine having a long extension handle, it being remembered that the bone will be very thin here. The opening is then enlarged by cutting the bone away in all directions, coming upwards and forwards as near the lateral sinus as is safe, and in a downward direction by cutting away the posterior margin of the foramen magnum. Above all, the bone surrounding the foramen of the mastoid emissary vein must not be cut or cracked, or uncontrollable hæmorrhage from the vein may occur. The dura mater is then freely opened and laid back. This will necessitate, in the midline, cutting and tying the occipital sinus. The cerebellum is then exposed and the necessary procedures performed. In the case of the fibromatous tumours usually growing from the eighth nerve, this is the approach employed, the cerebellum being gently drawn to one side; the tumour is then exposed and either curetted or sucked out from within its capsule.

Displacement of the cerebellum to one side is greatly assisted by (*a*) cutting the falx cerebelli, and (*b*) *tapping the ventricle* to diminish pressure. This is done by making a small opening in the skull about 1½ inches above and 1½ inches behind the external auditory meatus and directing the hollow needle towards the tip of the opposite auricle.

Pituitary Fossa. The methods of approaching this portion of the skull are described on p. 52.

The Middle Meningeal Artery. A description of the surface markings of this artery and the methods of exposing the vessel and tying it will be found in Vol I., Ch. X.

The Gasserian Ganglion and Root of the Fifth Nerve. This operation is described in Vol. I., Ch. XII.

CHAPTER III

DISEASES AND INJURIES OF THE SPINE

Surgical Anatomy. The spinal column in man forms a firm protecting case for the spinal cord as well as providing a central pillar for the rest of the skeleton, to which the ribs, the pelvic and pectoral girdles, the skull and many important muscles are attached. Between the individual vertebral bodies are placed the elastic intervertebral discs, and these provide buffers, which diminish shocks and jars as well as increasing the amount of movement permitted between the individual bones. Though the amount of movement permitted between each individual pair of vertebræ is small, the cumulative effect of these movements is great, and the spinal column as a whole permits of considerable anteroposterior flexion and extension, lateral flexion and rotation. The spinal column has certain natural curves. In the infant there is one long anteroposterior curve, concave forwards, but in the adult, and when the erect position is assumed, its shape becomes roughly that of an " S," the cervical and lumbar segments being convex forwards and the sacral and dorsal portions convex backwards. The portions of the spinal column most liable to injury are the sites where comparatively fixed and movable portions meet, *i.e.*, the dorsilumbar and cervicodorsal regions, while it must be remembered that the strength of the bones increases remarkably as we descend from the top to the bottom of the column.

The identification of certain individual spinous processes is important. The vertebra prominens (seventh cervical spine) and the first dorsal spine can be felt easily ; whilst in the neck the bodies of the upper cervical vertebræ can be felt at the back of the pharynx, and the cricoid cartilage lies at the level of the lower border of the sixth cervical body. The root of the scapular spine and the apex of the scapula correspond to the third and seventh dorsal spines (with the arm hanging by the side). The last rib runs back to the twelfth dorsal vertebra, the line joining the highest points of the iliac crests corresponding to the fourth lumbar spine, while the posterior superior iliac spines are at the level of the second sacral spine.

The spinous processes and bodies are not all at the same level. The cervical and first three dorsal spinal processes are roughly opposite the lower borders of the corresponding bodies ; the fourth, fifth, sixth and seventh dorsal spines are opposite the bodies next below, the remaining dorsal spines are opposite the lower borders of the next vertebral body below, but the lumbar spines are exactly opposite the middle of the corresponding bodies.

In examining a spinal case all movements, including flexion, extension and lateral flexion, must be examined and special attention paid to the question whether the spine is held rigidly in some abnormal posture ; while inasmuch as many spinal deformities are secondary to conditions primarily affecting the thorax or lower limbs, these structures also must be carefully investigated. An excessive convexity forwards of a segment of the spine is known as **lordosis**, a convexity backwards as **kyphosis**, while a lateral bending is known as a **scoliosis**.

The spinal cord lies within the vertebral canal and is surrounded by membranes which correspond to those surrounding the brain, the subarachnoid space being full of cerebrospinal fluid continuous with that round the brain and forming a similar water-bed. The dura mater, which corresponds only to the inner layer of the cranial dura, is attached to the bones only where the spinal and cranial membranes are continuous and where the spinal nerves pass out through the intervertebral foramina, and at this point these nerves receive a sheath from each of the membranes as they pass through the foramina, while the space between the dura and the bones is filled with fat and contains large venous sinuses. The dura ends opposite the upper border of the third piece of the sacrum, thus extending some distance below the spinal cord, which ends at the intervertebral disc between the first and second lumbar vertebræ. It is this feature which permits lumbar puncture to be performed with impunity, while it must be remembered that in the case of injuries below the first lumbar vertebra we are dealing with the nerves of the cauda equina and not with the spinal cord itself.

The spinal cord is protected from injury and from the movements of the spine most completely. In all movements of the spinal column it lies midway between the points of chief compression and chief extension, so that it is unaffected, whilst the curves of the column, the elastic intervertebral discs and the water-bed which surrounds it and in which it is loosely hung, suspended by the ligamenta denticulata, serve to protect it from the effect of jars and vibrations.

The cord is regarded as consisting of a number of segments, each of which gives off a pair of spinal nerves. These nerves pass outward from the spinal canal through the intervertebral foramina, but as the cord is much shorter than the spinal column each spinal segment is placed much higher than the spine of the correspondingly numbered vertebra, this discrepancy increasing as we pass down the column; thus the nerves run obliquely down the spinal canal to reach and pass out through their proper foramina, this obliquity also increasing, until below the second lumbar vertebra the cord has ended and the nerves run directly downwards within the dura to reach the lower lumbar and sacral foramina, this bundle of nerves constituting the cauda equina. A rough estimate of the correspondence of level of spinal segments and spinous processes may be obtained as follows :—In the cervical region the number of the spinal segment corresponding to a vertebral spine is obtained by adding " one " to the number of the vertebra; in the upper thoracic region add " two," and in the lower thoracic region add " three." The lower three lumbar segments and the sacral segments all lie between the eleventh dorsal spinous process and the second lumbar process.

The course of the fibres conveying motor and sensory impulses in the cord is described on page 2. The bulk of the spinal cord consists of long fibres, the bodies of nerve cells being also found in the grey matter. The most important groups of nerve cells, those which control the movements of the leg and arm, and certain reflex movements, such as the vesical, rectal, ejaculatory and patellar reflexes, are found in the cervical and lumbar enlargements. Surgical lesions affecting the spinal cord are usually bilateral, so that both sides of it are involved. They are rarely unilateral. Such a lesion may affect the cord, at a part where there are no nerve cells of importance. In this case only conducting fibres will be damaged, and all the signs and symptoms will be confined to parts of the body whose nerve supply leaves the cord below the injured segment. In other cases, where an important segment of the cord is actually itself damaged, not only will the fibres leading to the parts of the body below be involved, but important cells in that segment will be destroyed, so that the functions of the segment itself also will be interfered with. In other instances the cord itself will escape damage and the lesion be confined to the nerve roots after they have left it. Thus it will be seen that an injury to the spine may damage only conducting fibres and give rise to an upper motor neurone lesion, or it may destroy nerve cells or the actual nerve roots and thus cause a lower motor neurone lesion. For the full details of the anatomy, functions and lesions of the spinal cord, the reader must consult standard text-books on neurology.

As in the case of injuries of the skull and brain, so here we shall find that the clinical features, prognosis and treatment of an injury of the spine depend almost entirely upon whether the spinal cord or nerve roots are involved or not, and upon how much they are damaged. It is also to a certain extent true that any form of bony injury may here also be associated with any form of cord injury, but in the case of the spine it will be found that the correspondence between the type of cord injury and of bone injury associated with it is considerably closer and more constant than in the case of the skull and brain. Inasmuch as they are by far the most important and colour the whole picture, we shall describe the injuries of the cord first.

INJURIES OF THE SPINAL CORD

Concussion of the Spinal Cord. It is by some authorities regarded as doubtful whether a condition of spinal concussion analogous to cerebral concussion ever occurs. There is, however, little doubt that a condition is occasionally seen in which, following a severe injury or blow to the spine, a more or less total loss of all its functions instantly occurs, such a loss being transient and recovery of function recurring within a day or two at most. This phenomenon is, however, very rare, and its pathology is probably not the same as that of cerebral concussion, as the spinal cord cannot be regarded as being under the same conditions of hydrostatic pressure, within a firm, enclosing bony box, as maintain in the case of the brain. It is probable, therefore, that the symptoms are due to minute extravasations of blood scattered throughout the cord, as the result of bruising, or perhaps to a transient anæmia from vasomotor paralysis, or to œdema of the spinal medulla without any gross or visible damage. As such cases recover almost universally there is little opportunity of studying the post-mortem changes.

The symptoms of this condition are total, or almost total, immediate arrest of all the functions of the cord below the part struck, in combination with a considerable degree of shock to the whole system. Where the loss of function is total the condition will resemble exactly at first a total transverse lesion of the cord, but it is more common to find that, though the motor functions are completely abolished, sensory function is only partially affected. In any case the reflexes are lost, while in some instances the arms are more severely affected than the legs. If the condition is a true concussion the spinal cord will recover its functions within a few hours or a day or two at most, the reflexes returning first, then the sensation, and finally the motor power. In the cervical region instantaneous death is occasionally caused, while the loss of function will affect all four limbs. If the injury is lower down, only the legs and sphincters will be affected, while priapism probably never occurs in this condition. So rarely is this condition seen that when the symptoms of a total transverse lesion of the cord are present at first there is little chance of recovery occurring. Such a case occurred in the instance of an undergraduate who dived into shallow water in the River Cam and struck his head on the bottom; he was pulled out with all four limbs completely paralysed, but in the course of an hour or so the function completely returned and he was able to move arms and legs again, no permanent effects remaining. Thus it will be seen that for the first hour or two after such an injury it may be impossible to say for certain whether a total transverse lesion of the cord has occurred (see p. 96) or whether the condition is only one of spinal concussion, though unfortunately the chances are enormously against the latter condition being present. Partial lesions of the cord also may be accompanied by concussion, which at first increases their apparent severity.

Treatment. The treatment must be that of a total transverse lesion of the cord, and therefore will consist in absolute rest in the prone position and local applications in the form of an ice-bag or evaporating lotion. A careful watch must be kept for any alteration in the physical signs in the nervous system, and twenty-four hours' observation certainly will show whether the condition is simply a concussion or something far more serious. Skilled nursing and attention to the bladder and bowels will be required.

Spinal Hæmorrhage. Although a spontaneous spinal hæmorrhage occurs occasionally (especially in patients under twenty), the majority of cases in which hæmorrhage into the spine occurs are due to injury; and, conversely, the majority of injuries to the spinal cord will be accompanied by a certain degree of intraspinous bleeding. Such a hæmorrhage will occur either into the substance of the cord (hæmatomyelia) or outside the cord into the subarachnoid space (hæmatorrachis).

(*a*) **Extramedullary Hæmorrhage (Hæmatorrachis).** This is the less frequent variety of the two, and is usually accompanied by sprains or local fractures of the spinal column. The blood is effused sometimes between the bone and the dura, but more commonly in the subdural space, and the condition is seen nearly always in the cervical region. There are no signs of a gross fracture of the spine or of a fracture-dislocation with displacement (see p. 107), but the symptoms point at first entirely to irritation of nerve roots, *i.e.*, pain radiating along the course of the roots, hyperæsthesia in the areas supplied by them, and muscular cramps and spasms in the muscles which they supply. There is no paralysis at first, but this comes on gradually later, when the blood has collected in sufficient quantity to produce pressure upon the cord or severe pressure upon the nerve roots. In the cervical region, which is the commonest situation, the arms are affected first, and more than the legs, the arm paralysis being of the lower motor neurone type, with flaccid and atrophied muscles, while the leg paralysis is of the upper motor neurone type, with brisk knee jerks. In some cases blood trickles down within the dura and collects at a level considerably lower than the lesion, giving rise to a paralysis which gradually spreads from below upwards as the bleeding increases (**gravitation paraplegia,** Thorburn). In this condition there is no temperature and little shock; the cerebrospinal fluid contains blood, while the signs of spinal irritation are more marked, and the paralysis comes on much more slowly than in the next condition.

Treatment. The treatment is that of a total transverse lesion (see p. 98). Ice may be applied to the spine, and coagulin (hæmoplastin) or adrenalin may be injected to try to stop the bleeding. If there is evidence of increasing pressure upon the cord, an effort may be made to withdraw the blood by a lumbar puncture, while occasionally laminectomy may be required to relieve pressure or pain. This is, however, rare.

(*b*) **Intramedullary Hæmorrhage (Hæmatomyelia).** A traumatic hæmorrhage into the substance of the cord is rather more common than the foregoing condition. It is hardly ever seen except in the cervical enlargement, and it is as a rule not associated with fractures or injuries of the spinal column, but occurs as the result of forcible accidental flexion of the neck, which stretches the spinal cord. The effused blood is not usually large in amount, and takes the form of one or two small clots in the grey matter amidst the anterior horn cells. Thus the grey matter is ploughed up to a small extent and certain nerve cells are lacerated and destroyed, while white matter probably will be to a certain extent compressed by the hæmorrhage. If the hæmorrhage is extensive it may burst into the subdural space or the central canal.

Clinical Features. In this condition the symptoms are paralytic from the commencement, without preliminary pain and irritation. Following an accident which acutely flexes the neck, but does not usually produce a fracture, the patient suddenly becomes completely paralysed in all four limbs, though the signs of a complete lesion of the cord are absent. The paralysis of the arms is flaccid and due to the destruction of the anterior horn cells, while that in the legs is due to pressure upon the descending fibres, so that this will be of the upper motor neurone type. There probably will be a slight amount of pain and a slight rise of temperature. Thus the paralysis of the legs will be spastic, with brisk reflexes, while that of the arms will be flaccid, with absence of reflexes and marked muscular wasting. When the extravasation of blood is severe there will be sensory changes also in the legs, and these sensory changes are usually only temporary and consist of an anæsthesia for temperature and pain; when the hæmorrhage is near the central canal there may be dissociation of sensations. There is nearly always retention of urine and priapism, while in certain cases, where the ciliospinal centre in the cervical cord is involved, there will be marked contraction of the pupil. If the hæmorrhage is very extensive, the cord may be practically in a condition of total transverse division (see below), but this is rare. A considerable degree of recovery usually follows in the course of a few weeks unless the damage is very extensive, and those parts whose paralysis is due to pressure only will probably recover completely. Thus recovery in the legs may be looked for, sensation returning before motor power, though it is possible that certain muscle groups may remain permanently spastic. On the other hand, those parts whose paralysis is due to destruction of nerve cells will not recover completely, so that permanent changes usually remain in the arms. It often happens that the centres controlling the flexor muscles of the arms and hands remain unaffected or recover satisfactorily, while the extensor muscles are flaccid and paralysed. The patient then lies in bed in a very characteristic attitude, with his elbows, wrist and fingers flexed and both hands drawn up to his chin. In the cervical region it occasionally happens that death occurs rapidly from respiratory paralysis, while in many cases secondary spinal degenerations follow upon the condition later on.

Treatment. Operative treatment in the form of laminectomy is here definitely contra-indicated, as it can do no good. Treatment consists in absolute rest with great attention to the nursing, the bladder and the bowels, while later orthopædic measures may be required to relieve any paralytic or spastic phenomena which may persist.

Total Transverse Lesion of the Cord. Unfortunately complete lesions of the spinal cord are far more common than partial ones, and as there is no evidence that portions of the spinal cord which are completely crushed or torn can undergo any regeneration whatsoever, such a lesion must be regarded as irremediable; there is thus no further prospect of conduction of nerve impulses up or down the cord across the damaged portion, though the lower, isolated segment of the cord still may preserve many important reflex functions. The causes of a complete transverse lesion are many. A complete dislocation of the spine or a fracture-dislocation almost invariably causes it, and even if the crushing of the cord is only instantaneous and the bones are immediately reduced or move back into place spontaneously, irreparable damage is done. Stabs and gunshot wounds also will produce this lesion, while cases have occurred in connection with gunshot wounds where, although there was no evidence that the bullet had entered the canal or driven bone fragments in upon the cord, the cord in the neighbourhood of the wound had degenerated into a soft, pultaceous material without any conducting power. Complete transverse lesions of the cord also are seen occasionally in the later stages of spinal tumour, or in connection with other forms of pressure upon the cord. In the case of injuries of the spinal column a transverse lesion is most commonly produced by the actual displacement of the bones crushing the cord, but it is occasionally the result of a hæmorrhage (see p. 95) or, at a later date, of the pressure of an inflammatory exudate. Later still the formation of callus or of adhesions within the meninges may be responsible for it. The results of a division of the spinal cord, either partial or complete, are spoken of as paraplegia.

Clinical Features. These depend entirely upon the level of the lesion. In the case of an injury to the spine the site of the bone injury will usually determine the level of the cord lesion, with the possible exception of a gravitation paraplegia (see p. 95), and an examination of the bones of the spine must in such a case be made with great care. The symptoms of this lesion where one segment of the cord is completely destroyed are due partly to injury to nerve cells, and possibly to nerve roots at the actual site of the lesion, but chiefly to the fact that the whole of the cord below the lesion is completely isolated from the brain. This first group of symptoms consists of immediate flaccid paralysis of the muscles supplied by the injured segment, with disappearance of reflexes and marked atrophy and reaction of degeneration, while a narrow zone of hyperæsthesia, accompanied by tingling, formication or girdle pains, due to irritation of nerve roots at the site of the lesion and associated with radiating pains, may be present; any reflex phenomena in which the damaged segment is concerned will also disappear. The signs due to interference with the conduction of the cord are an immediate total paralysis and complete anæsthesia below the level of the lesion. Thus there is an immediate flaccid paralysis of all the muscles whose nerve supply emerges below the injury; their wasting is not marked, nor is there any reaction of degeneration, and it is only after an interval when secondary degenerations have occurred in the cord in the anterolateral columns that the muscles become rigid and contracted and the knee jerks may return or become increased. This onset of rigidity may be accompanied by violent muscle jerkings and cramps. If the lesion of the cord is complete, the paralysis will be complete and symmetrical in the two sides. The anæsthesia below the lesion is complete to all forms of sensation, and commences immediately below the zone of hyperæsthesia already described; anastomosis between the various spinal sensory nerves will at times rather alter the level of the anæsthesia. All the reflexes, deep and superficial, are permanently lost, though occasionally after a few months the deep ones will reappear sometimes, and it must be remembered that the presence of marked septic infection in the patient's system certainly will prevent this return of reflexes. Retention of urine, and usually retention of fæces, the result of spasm of the bladder and rectal sphincters, are always present at first, and if the lesion is above the lumbar centres the bladder will become distended, with dribbling overflow, unless relieved by catheterisation (false incontinence). This is the result of the disappearance of voluntary control permitting the sphincters to pass into tonic contraction. After a time the tone of the bladder returns and the tonic action of the sphincter lessens, so that the bladder may commence to expel the urine forcibly at intervals without the patient knowing it. In many cases, after some months the so-called "automatic bladder" becomes fully established, in which, when the bladder becomes moderately full, or sometimes as the result of various stimuli, such as scratching the inside of the thigh, the viscus contracts automatically and expels its contents involuntarily and unconsciously. True incontinence will occur if the lesion is in or below the lumbar centres (see p. 98). Priapism, a condition where the penis is semi-erect, swollen and turgid as a result of vasomotor paralysis, is common, while there may be dilatation of subcutaneous vessels, local elevation of temperature and trophic lesions, both in the bladder, rectum and skin, the latter appearing especially over pressure points. In some cases the extremities are blue and cold, the skin dry, and the tissues œdematous. Grave complications very often set in in the form of hypostatic pneumonia, sloughing of the skin over the sacrum and back, constipation and tympanites, while cystitis is frequent and easily set up unless catheterisation is conducted with the greatest possible care. When this occurs it is of an exceedingly virulent kind, and may be accompanied by hæmorrhage, sloughing of the bladder mucous membrane, and septic pyelonephritis. Severe and agonising bladder spasms may occur, while the kidney infection is a very frequent cause of death.

If on examination of the central nervous system any trace of any form of sensation can be found below the injury, or any muscle whose nerve of supply emerges below the injured spot is found to be unaffected, it may be assumed that the damage to the cord is not a complete transverse lesion.

Treatment. When the cord is completely divided no operation upon it will produce any benefit, and there is no hope of any return of its function. The treatment, therefore, consists in the prevention of complications and careful nursing, with attention to the bladder and the bowels (p. 883), and though some cases develop an automatic bladder and remain comparatively comfortable and free from infection, the prognosis of all complete lesions is bad, and it is worse the higher the lesion. Death may occur early or late, and may be due to respiratory failure, chest complications, severe bedsores and sloughing of the buttocks, with septic absorption, and most commonly to infective bladder and kidney conditions, frequently accompanied by the formation of stones (see also pp. 834, 870).

There is little doubt that if a permanent suprapubic drainage is done in these cases quite early before infection of the bladder sets in or as soon as it has done so, infection of the kidneys may be prevented and life be prolonged for a very long time.

Spinal Injuries at Different Levels.

(A) **Lumbo-Sacral.** The spinal cord coming to an end in the upper lumbar region at the lower border of the first lumbar body, an injury in the lumbosacral region will involve, not the cord itself, but the nerves of the **cauda equina.** In this situation lesions are found not uncommonly which involve either the whole cauda equina or, more commonly, only parts of it, and the symptoms will depend upon the extent and level of the nerves damaged. Usually all the muscles in the legs are paralysed except those supplied by the anterior crural, obturator and superior gluteal nerves, the paralysis being of a lower motor neurone type, and the perineal and penile muscles may also be involved. There is no priapism, but there is a large anæsthetic area, which involves the greater part of the legs, except the portions supplied by the anterior crural and external cutaneous nerves, while the penis, scrotum, perineum and lower portion of the buttocks will also be insensitive. The bladder and rectum may be affected in the way already described on p. 97, but in this instance it is more common to find true incontinence of both functions, true incontinence of the bladder meaning that its sphincter is paralysed and the urine flows out of the bladder as fast as it flows in, so that the organ is always empty. Lesions of the cauda equina are often incomplete and asymmetrical; if the lesion is below the fourth lumbar segment the knee jerk may not be affected.

Treatment. In this case the risk to life is considerably less than in other spinal lesions, but the liability to bladder infections is still present. As we are dealing here with what are really peripheral nerves and not the spinal cord, recovery with regeneration is possible, and if there is evidence of any of the nerve roots being completely divided, operation should be undertaken to suture them. Laminectomy is performed in the way described on p. 148, the dura opened, the roots identified and sutured.

Conus Medullaris. A heavy fall in the sitting position occasionally will produce a lesion of the conus medullaris, in which there is anæsthesia over a saddle-shaped area of the buttocks, the top of the thighs, perineum and scrotum, and also in the urethra and anal canal, the third and fourth sacral nerves being affected. The legs are weak, but not definitely paralysed, but there is paralysis of the bladder and rectal sphincters. There will be no anal reflex, while the levatores ani are paralysed. Testicular sensation is unaffected.

(B) **Dorsi-Lumbar Region.** When the lesion is slightly higher and in the neighbourhood of the eleventh and twelfth dorsal and first lumbar vertebræ (a common situation), there will be complete paralysis of all the muscles of both legs and the muscles connecting them with the trunk, while there is complete anæsthesia of the legs, buttock, perineum and infra-umbilical region of the abdomen, the whole of the lumbosacral plexus being involved. Here again there will be paralysis of the bladder and rectal sphincters, so that true incontinence of urine, with an empty bladder and without any retention and incontinence of fæces, will occur; priapism will be absent. The prognosis here is fairly good, though the usual liability to bedsores and urinary infections will be present. The abdominal muscles are unaffected, so that coughing is possible and pneumonia less likely, while distension and constipation will be much less marked than in the case of higher lesions, and respiration will not be affected at all. The level of the tenth or eleventh dorsal vertebræ is a very favourite site for injuries to the spine.

(C) **Thoracic Region.** In the thoracic region from the second to the eleventh vertebræ there is complete anæsthesia and paralysis below the level of the lesion, the anæsthesia running horizontally round the body and not obliquely, being absolute and ending above in a narrow zone of hyperæsthesia, which feels to the patient like a tight, painful girdle. As well as involving the legs, the paralysis will now include the flat abdominal muscles and some of the intercostal muscles; thus respiration is to some extent hindered and the patient is unable to cough, this bringing with it a considerable liability to hypostatic pneumonia, while the patient being unable to strain in order to expel flatus or fæces, constipation and tympanites with distension are marked, and this meteorism will further hinder respiration; the fact that the ribs cannot be steadied by the intercostal muscles renders the action of the diaphragm less efficient. There will be retention of urine, followed by dribbling incontinence, and leading later in some cases to an automatic bladder (p. 883). The liability to pneumonia, bladder and kidney infections and bedsores is great, while in some cases an ascending myelitis will set in. In the rare event of none of these complications occurring, such a patient may live for many years.

(D) **Cervico-Dorsal Region.** Here similar phenomena are present, while the anæsthesia will involve more or less the whole of the trunk, and the hyperæsthesia may spread on to the arms. Respiration is even more embarrassed, as it can be performed only by the accessory muscles and the hampered diaphragm; thus bronchitis and pneumonia are fatal and common.

If the lesion is confined to the *first dorsal segment*, there will be ocular changes depending on sympathetic paralysis, anæsthesia to the top of the chest and down the distribution of the ulnar nerve, while the patient lies with the arms slightly abducted at the shoulder, and flexed at the elbow, the forearms pronated and the fingers bent.

If the *sixth cervical segment* alone is injured there are similar sympathetic changes, but rather a more extensive loss of sensation, and the patient lies again with his arms abducted and rotated outwards at the shoulder, the elbows and fingers more sharply flexed, but the hands supinated. Priapism is common in these lesions, and death almost invariably occurs within a few weeks from respiratory complications.

(E) **Cervical Region.** Complete lesions of the upper four cervical segments lead to death, either instantaneously or within a few seconds, as they result in total paralysis of the phrenic nerves and immediate stoppage of respiration. This is the cause of death when hanging is performed by a skilled executioner.

In lesions immediately below the fifth cervical segment, both arms and legs are paralysed and completely anæsthetic. Sensation on the trunk remains unaffected above the second intercostal space in the distribution of the supraclavicular nerves, which come from the third and fourth cervical segments. Paralysis of the sympathetic will be present and give rise to contraction of the pupil, narrowing of the palpebral fissure, recession of the eyeball within the orbit and dryness of the skin. In this case respiration is carried on entirely by the diaphragm and only with difficulty. Hiccough is sometimes seen, and there will be retention of urine followed by dribbling incontinence. Priapism is very common, whilst the pulse often will be very slow from paralysis of the sympathetic cardio-accelerator fibres, and the temperature sometimes very high. In all these cervical cases the patient usually dies within two or three days, sometimes with hyperpyrexia and sometimes from respiratory embarrassment and complications.

Incomplete Divisions of the Cord. These are not uncommon and include such conditions as partial lacerations, bruises and injuries to the nerve roots. Hæmorrhage into or outside the cord is also present usually, while some minor form of damage to the bones of the vertebral column will be found In most of these cases the signs and symptoms for the first few hours or days are exactly those of a total transverse lesion, there being a large element of shock present, and it is only after an interval that a partial return of function will prove that the division is incomplete.

Thus there will be complete flaccid paralysis, complete anæsthesia, complete loss of all reflexes and retention of urine, and it is only after some days' observation that signs of partially returning function will give a clue to the diagnosis. If immediately after the accident there is any trace of reflexes, motor power, sensation, or any asymmetry between the two sides of the body with respect to these conditions, we can feel quite certain that the lesion is not total. The reappearance of some degree of sensation or motion, of a deep reflex or an extensor plantar response is the signal that the lesion is not complete, and in such a case, after a slow and gradual improvement, lasting many months, the condition will become stationary and the patient will be left permanently in an incompletely paralysed condition, the extent of which will depend upon the severity of the damage. As a rule, in the final stage the loss of motor function is more marked than that of sensation, and the distal parts of the limbs are more affected than the proximal. Spasticity probably will set in with increased knee jerks, while such sensory phenomena as persist may be either of the nature of an anæsthesia or a hyperæsthesia. Similarly, after the concussion has passed off, retention of urine or of fæces and priapism will not always persist, while in some cases sensation in the bladder or rectum may be present, though the patient has lost control of the power of emptying these organs.

In the rare cases where nerve roots alone are damaged there will be motor paralysis of various muscle groups, according to the nerve roots injured, and of the lower motor neurone type. Twitchings and cramps are not seen, but in addition to anæsthesia there probably will be tingling, formication and radiating pains.

Hemisection of the Cord. Occasionally as the result of bullet wounds a lesion is seen which appears completely to destroy one lateral half of the cord, and in this case the so-called Brown-Séquard syndrome occurs, namely :

1. On the side of the lesion there will be complete motor paralysis of the legs of the upper motor neurone type, with brisk knee jerks, and an extensor plantar reflex, tending to become spastic, while there will be loss on this side of the sensations of vibration, joint position, and partly of light touch.

2. On the side opposite to the lesion there is loss of cutaneous sensation to temperature and pain and partially to touch, but no paralysis whatever.

Treatment. In a partial lesion of the cord the prognosis as to life is far better than in a total lesion, for although bedsores, chest complications and urinary infections occur, they are far less common and less virulent. If one-half of the cord, or even a few isolated fibres, are intact, they will be sufficient, in some cases, to preserve the bladder function.

A certain varying amount of recovery of function will occur during the first few months after the injury, although some permanent changes are bound to remain. The first signs of recovery are usually return of the knee jerks, the onset of spasticity, return of sensation to touch in the sacral nerves, and finally the onset of voluntary movement again in the flexor muscles, this first being seen in the flexors of the toes.

The treatment in general is the same as that of a total lesion (see also p. 98), but in some cases of partial lesion a laminectomy may be beneficial. This is so only when there appears to be pressure upon the cord, due either to displaced fragments of bone, foreign bodies, hæmorrhage or inflammatory products. Laminectomy also may be considered occasionally where the lesion appears to involve nerve roots. For its performance, see p. 148. The question of operation upon injuries of the spine is always a difficult one ; we must repeat that no completely crushed or damaged portion of spinal cord will ever regain its function whatever treatment is adopted ; any procedure, such as suture, is therefore out of the question in the cord itself.

The indications for and against laminectomy in injury of the spinal cord therefore may be taken as follows :—

(*a*) In concussion—never.

(*b*) In a total transverse lesion—never, except with the one object of relieving pain due to pressure upon nerve roots, which is very rare.

(*c*) In partial lesions. Here it must be remembered that for some hours or days it probably will be impossible to say which of the three conditions, concussion, total division, or partial division, is present, and there should be, therefore, no question of laminectomy until this question is settled. The operation may then be undertaken :—

1. Where the neural arch, lamina or other part of the bone appears to be driven in upon the cord.

2. In lesions below the first lumbar vertebra, for here we shall be dealing with the cauda equina and not the spinal cord itself.

3. Where the symptoms come on or appear to increase some hours or days after the accident, for here there may be pressure due to hæmorrhage or inflammatory products. If, however, a transverse myelitis is present, opera-

tion can be of no help. At a later date still, after some weeks or months, if symptoms of irritation or paraplegia supervene, they are due probably to scar tissue, callus formation, or local accumulations of cerebrospinal fluid (see p. 139), and in this case operation probably will be of great benefit.

4. In penetrating wounds; here the operation is done chiefly with a view to removing damaged tissue, bone fragments, etc., and diminishing the likelihood of septic infection.

5. Occasionally in cervical dislocations, if the patient is fit for an operation, and where the cord does not appear to be completely crushed.

Spinal Meningitis. Though sometimes this arises as a complication following a spinal injury, it is more commonly due to independent disease and will be described, therefore, on p. 138.

Spinal Myelitis. This is also more common as the result of disease, though it is not infrequently seen after an injury. For its description see p. 138.

Traumatic Spinal Neurasthenia ("Railway Spine"). This is a condition which is seen in persons who have been in railway and motor accidents and also in men who are engaged in heavy occupations, such as miners or navvies, who have met with similar severe accidents. There usually will be a history of some minor degree of trauma to the spine, but only of the nature of a bruise or sprain and practically never as severe as a fracture, while in some cases the injury has never been directed to the vertebral column at all, but to some limb or other part of the body altogether. There are no, or few, symptoms immediately after the accident, but some weeks later features set in which appear to be more cerebral than spinal. The condition is seldom seen in passengers who are grossly injured in any way, or in the employees of the railway company, and it usually leads to claims for compensation and law suits. The probable reason why railway accidents especially lead to it is that the shock is great and unexpected, while terror and mental disturbance are marked at the time of the accident, and very violent forces are at work.

Clinical Features. In most cases the signs and symptoms produced are those of neurasthenia. At the time of the accident the patient is usually thrown from side to side and bruised or shocked, but he is not usually unconscious and never severely damaged. In a few hours or days he complains of backache or headache and of feeling weak and nervous, and finally he finds he has to give up his work or business altogether. A host of subjective symptoms develop, such as weakness, nervousness, sleeplessness, bad dreams, lack of concentration, irritability, giddiness, fulness in the head, noises in the ears. He usually has loss of memory except for the details of the accident. There is frequently loss of sexual power and irritability of the bladder, while he states that his back is painful and tender at certain spots. Formication, tingling and burning sensations are marked, but indefinite in situation, while the pulse may be weak, the temperature subnormal and the patient lose weight. There are no physical signs to be detected in the nervous system. Mental excitement and exertion usually make all the symptoms worse, but the satisfactory settlement of a claim for damages in his favour produces a marked improvement, which may be due to the removal of mental anxiety and excitement. In many cases the condition is perfectly genuine neurasthenia, though it is always difficult to exclude the possibility of malingering. Though the condition is usually chronic and persists for weeks and months, it is occasionally seen in an acute form immediately after the accident, the patient lying prostrate and unable to move, in a semiconscious state. It will be seen thus that in many ways it closely resembles "shell shock."

Treatment. This consists in general tonic treatment of the type usually adopted for neurasthenia, though it should be preceded by rest for a considerable time. Bromides should be given in reason and local applications up to a certain point, but they must not be persisted in sufficiently to fix the patient's mind upon the local condition. Very little improvement is usually seen to occur until compensation claims are favourably settled and litigation has ceased.

INJURIES OF THE SPINAL COLUMN

Injuries of the vertebral column fall into two main groups :—

(*a*) *Partial lesions,* where the continuity of the column as a whole is not interfered with. These injuries consist of sprains, twists, partial or complete dislocations of individual articular processes, and compression fractures of the vertebral bodies, neural arches and spinous and transverse processes. In these instances damage to the cord is slight or absent.

(*b*) *Complete lesions,* which are total dislocations and fracture-dislocations. Here the column as a whole is broken across and the cord is always severely damaged. In these lesions the upper segment of the spine is always displaced forwards, while it will be found that fracture-dislocations are most common in the dorsal region, fractures in the lumbar region, and sprains and dislocations in the cervical region.

Sprains. These are very common and are the result of sudden stretching of the ligaments and muscles round the spine. There will be no effect upon the spinal cord unless the ligamenta flava are damaged, in which case the extravasation of blood produced sometimes will pass in between the dura and the bones and give rise to pressure upon the cord. Nerve roots passing out in the neighbourhood of the sprain sometimes will be damaged or stretched. These sprains are most commonly seen in the cervical and lumbar regions, which are the most mobile parts of the spine. In such a sprain there will be marked pain and tenderness over the damaged spot, with a little swelling and bruising. All movement is painful and any movement which tends to stretch the damaged muscle or ligament is excruciating, and the spine is therefore held rigidly at rest, the muscles on both sides being tightly contracted. Active or passive movements which stretch the injured structure are equally painful, while movements which tend to relax the damaged structure are painless if passive, but painful if active and the injured structure is a muscle. An X-ray plate will show no changes in the bones at all. Very occasionally infection of the damaged tissue will set in, and it may spread so as to involve the cord and meninges, while tuberculous caries appears to be set up sometimes as a result of such injuries in patients with a predisposition thereto.

In the **cervical region** forcible flexion or extension of the head is usually the cause. The pain is severe and the head cannot be moved, while it is often held firmly in a position of torticollis (see p. 389). The maximum point of tenderness will indicate the site of the damaged structure.

In the **lumbar region** severe sprains occur as the result of lifting strains and railway accidents. The back is held absolutely rigid and the patient cannot stoop or turn without pain, the symptoms closely resembling those of acute lumbago.

Sacroiliac strain is the name given to a condition usually seen in women, where there is severe pain in the neighbourhood of the sacroiliac joint, worse after walking or standing, but unaccompanied by any signs suggestive of an inflammatory affection of the joint. It is relieved by manipulations to relax the strain on the joint and by apparatus to support it.

Fractures and dislocations may be excluded in these injuries by there being no alteration in the bony points, no deformity of the spine as a whole, by the fact that minor degrees of passive movements, though painful, are possible, and by the X-ray appearances.

Treatment. The patient should be kept absolutely at rest in bed, with hot fomentations locally and salicylates to relieve the pain. If the injury is in the cervical region a light extension should be applied to the head. In four or five days, after the acute pain has passed off, massage and passive movements may be practised, but there should be no active movements until the passive ones are quite painless. These sprains, unless carefully treated, are liable to lead to prolonged disablement, the patient complaining of chronic pain and weakness in the back, so that in severe cases quite six or eight weeks' rest in bed may be needed. Complications in the form of paraplegia from pressure or the onset of infection in the muscles or the meninges must be watched for.

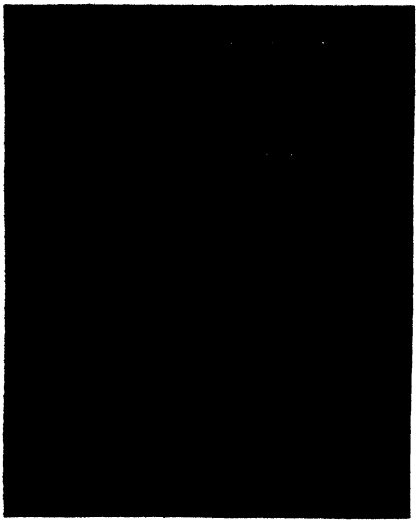

FIG. 26. Fracture of the body of the third lumbar vertebra.

Fractures of the Spine. Fractures of the spine may be due to :—

(*a*) Direct violence, such as a blow on the back, a gunshot wound, or a fall over a projecting body, such as a wall or bench. These fractures are rare. The injury will occur at the point struck and probably will involve the posterior parts of the vertebræ.

(*b*) To indirect violence, where they are the result of forcible flexion of the spine, caused by such accidents as falling downwards on the head, diving into shallow water, the dropping of heavy weights upon the shoulders or head, riding accidents, or in the case of people being driven in a vehicle under a bridge and getting caught between the arch and their conveyance. These fractures usually occur in the cervical or dorsal regions, and in the latter case are frequently accompanied by a fractured sternum. Such a fracture may be either complete, where the spinal column breaks right across, or incomplete, and involve only the bodies or processes.

(A) **Incomplete Fractures.** These are usually due to direct violence and consist of isolated fractures of the spinous processes, laminæ, transverse processes and bodies.

Fracture of the spinous processes is seen only in the dorsal region, and is accompanied by bruising of the overlying tissues, irregularity of the line of spines, and possibly crepitus and abnormal mobility of the spine concerned. Pain and tenderness are very great. Cases have been recorded where a spinous process has been driven in upon the cord and produced paraplegic symptoms.

Fracture of the laminæ is not uncommon, and frequently due to bullet wounds. If only one lamina is broken, the signs and symptoms are confined to severe local pain and tenderness, while an X-ray will be required to demonstrate the fracture. In this case it is not likely that there will be any damage to the cord or nerve roots. When both laminæ are fractured, displacement of the spinous process in the form of depression is probable, while crepitus can often be obtained and the irregularity in the spine noted. In this case the arch very probably will be driven in and cause direct pressure upon the cord (assisted possibly by a surrounding hæmorrhage), sufficient to give rise to paraplegic symptoms.

Fractures of the transverse processes are not uncommon, and are due to direct violence; they often occur while playing Rugby football. They are especially seen in the lumbar region, and give rise to great pain, tenderness and rigidity. They cannot be diagnosed for certain without an X-ray plate. It is possible that some of the cases of persistent pain in the back following injuries which were thought to be sprains are due to this fracture.

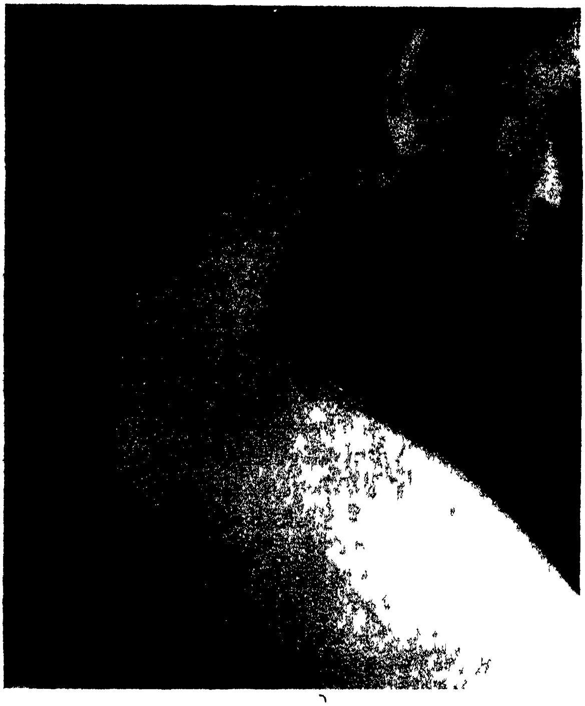

FIG. 27. Deformity and rigidity following a fracture of the upper dorsal spine.

Treatment. The treatment of these injuries consists in keeping the patient at rest in bed. An extension may be useful, and in the later stages massage will be required. If, however, there is evidence of pressure upon the cord, either from hæmorrhage or from depressed fragments of bone, immediate laminectomy must be undertaken to relieve this pressure.

Partial Fractures of the Bodies (*Compression Fracture*). This fracture is due to the crushing of the bodies of one or more vertebræ, all other parts of the vertebræ being unaffected and there being no lateral displacement. It is the result, therefore, of heavy falls upon the feet, buttocks or head. The lumbar or lower thoracic region is usually involved if the patient lands upon his feet or buttocks, and if he selects his head to land upon, the lower cervical or upper dorsal may be crushed. The sternum is not infrequently fractured in association with this injury, and every case of fracture of the sternum should always suggest the possibility of a fractured spine. There is severe pain, tenderness and rigidity over the segment of the spine affected, with bruising and the projection of one or two spinous processes backwards at the damaged spot. It must be remembered that in the lumbar region such a projection may take the form merely of an obliteration of the normal lumbar concavity. The cord in this injury usually escapes damage, but nerves emerging in the neighbourhood may be injured, and other serious lesions in the head, limbs, or trunk are very often present.

Treatment. An effort should be made to pull the column out in hyperextension and take the pressure off the damaged bones by means of an extension applied, in the cervical region, to the head, with a small pillow placed beneath the neck, and in the lumbar region in the legs, with a pillow behind the loins. The patient will have to remain in bed for eight weeks at least, but should have massage and gentle passive movements after three weeks ; if, however, an adequate plaster of Paris jacket is applied in hyperextension the patient may be allowed up to follow his occupation in the course of a few days. Very careful nursing will be required, as he must not be permitted to move or roll about, unless in a plaster jacket. For three months after he gets up he must wear the supporting jacket, or if he has been nursed in bed with pillows, must be fitted with a jacket of poroplastic felt or leather.

(B) **Complete Fractures.** Complete fractures of the spinal column, in which the continuity of the whole spine is broken and displaced, unfortunately are common. As in nearly all these cases there is a fracture of one or more vertebræ, together with a slipping of the whole spinal column above it, the injury is usually known as a **fracture-dislocation,** this being what is popularly described as a " broken back." A pure complete dislocation of the spine without any fracture is occasionally seen (see p. 109), but it is very rare, and in any case is difficult to distinguish clinically from the above condition. A fracture-dislocation may occur in any part of the spine, but is most common in the dorsal or dorsi-lumbar region, being especially frequent in the neighbourhood of the fourth dorsal vertebra. The fracture is due almost always to indirect violence, and is the result of forcible flexion of the spine as the result of falls on the head and shoulders, crushes, and the dropping of heavy weights upon men in a stooping position ; thus the fracture occurs at the point where the flexion is most acute. The damage is usually extensive, there being a complete bilateral dislocation of the articular processes, which are usually fractured as well except in the cervical region, whilst the ligaments are torn and the bodies of one or two vertebræ are fractured in a direction which runs obliquely downwards and forwards ; thus the upper half of the spine slides downwards and forwards upon the fractured bodies of the lower part. Impaction may be present, while in some instances the spinous or transverse processes also will be fractured. The spinal cord is crushed between the arch of the vertebra above the fracture and the posterior edge of the vertebral body which is fractured. The displacement is sometimes partially reduced immediately by the bones spontaneously recoiling into position, but unfortunately the cord is almost always irremediably crushed. The membranes are occasionally pierced by splinters of bone, while hæmorrhage often will occur within or outside them. Not infrequently in dorsal fracture-dislocations there is also a fracture of the sternum.

Clinical Features. In addition to marked general shock, the local signs are usually obvious and consist of severe pain, swelling and bruising, with a noticeable angular deformity, the pain being both local and also referred along any crushed nerve roots. The patient must be moved very carefully indeed and must never be turned over. The back can be examined while he is lying flat, and in addition to the angular deformity there will be a prominence of one or more spinous processes, the most prominent one being that of the vertebra which is fractured, while the one above this can be felt to have slipped forwards. No attempts must be made to elicit movements or crepitus, but an X-ray plate should be taken, and always will show the lesion. The most important part in the diagnosis is an investigation of the state of the nervous system, and, unfortunately, it will be found nearly always that the signs and symptoms of a total transverse lesion of the cord, described on p. 97, are present; conversely, when these symptoms are found, it is almost certain that a fracture-dislocation has occurred. In a few very lucky cases the signs and symptoms may be those of a partial lesion of the cord (see p. 100). The prognosis of such injuries is bad and depends entirely upon the amount of damage done to the cord and its situation. The mortality in all cases of fracture-dislocation is over 75 per cent., being due to respiratory failure in the high cervical cases, and in other cases to respiratory embarrassment and hypostatic pneumonia, bladder and kidney infection, bedsores, sloughing of the nates and septic absorption. In the case of very high up fracture-dislocations between the atlas and the axis, death is instantaneous from crushing of the medulla by the odontoid peg which is driven into it. Cases of fracture of the odontoid process are occasionally seen where the transverse ligament prevents any displacement, so that the cord is uninjured and the patient merely complains of great pain and stiffness in his neck, while an X-ray film will demonstrate the damaged peg. The greatest care must

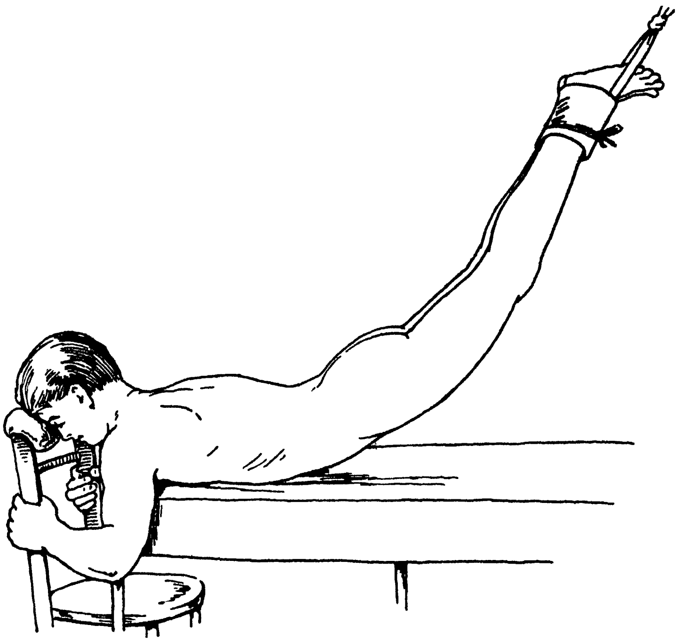

FIG. 28. Patient hyper-extended before application of plaster of Paris splint.

be taken in such a case, for if the ligaments give way and the bone slips forwards instantaneous death will occur. This has happened in some such instances from softening of the transverse ligament, or as the result of injudicious movements months afterwards.

Treatment. In the first-aid treatment of these cases, it is most important to keep the patient on his face so as to keep the spine in a hyper-extended position and prevent any damage occurring to the spinal cord. Cases should be transported on a stretcher, lying face downwards, the head and shoulders being supported by a pillow or folded blanket. If the patient has to be turned over to get into this position, great care must be taken to turn the patient as a whole, in order to prevent twisting and shearing off of the spinal cord at the site of fracture, otherwise he is better transported as he lies. Throughout he must be handled most gently so as not to increase the damage to the cord and should be laid face down on a flat, firm bed consisting of a mattress over fracture-boards, the shoulders and hips being supported to keep the spinal column fixed in a hyper-extended position and so prevent further damage to the cord. Water beds may be required later on, but should be avoided at first, if possible, as they are not firm enough ; nor are spring mattresses suitable. Shock must receive appropriate treatment, remembering that the anæsthetic parts of the body may be burnt easily by hot-water bottles, while it also must be remembered that it is quite likely that the patient will be suffering from other severe injuries in the head, abdomen or legs. In many cases the deformity rights itself when the patient is laid flat, but if this does not occur an attempt may be made to reduce it under an anæsthetic by means of gentle traction in the long axis of the body, while a roller pillow is placed under the fracture. As an alternative method the patient can be slung in a hyper-extended position in a canvas sling, the shoulders and arms being supported on one table and the feet secured at a higher level. A plaster jacket is now applied, with the patient in this position of marked hyper-extension ; this jacket must fit accurately over the pelvis, be sufficiently high to support the shoulder girdle, and should be worn for at least three months. By these measures, patients who appear to have a hopeless transverse lesion of the cord will sometimes improve, presumably owing to the effects of the œdema and hæmorrhage wearing off. Nursing of these cases is greatly facilitated, as the patient in a plaster jacket can be turned in bed.

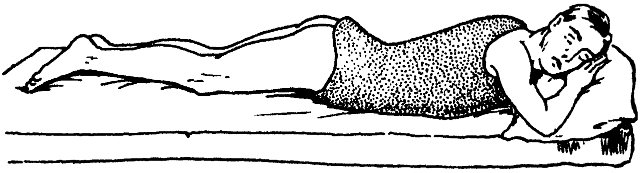

FIG. 29. Plaster of Paris splint applied.

Reduction, however, should never be attempted in the cervical region nor if the injury to the spinal cord appears to be incomplete, for fear of increasing the damage. Operative treatment seldom holds out any prospect of improvement, its indications being discussed on p. 101. In most cases the treatment consists in the relief of symptoms as they arise, and in most careful nursing. The patient should remain flat in bed, with the head low, and a nourishing and light diet. The skin of the back must be most carefully looked after and the greatest care taken to avoid bedsores, a Pearson bed with a divided mattress often being invaluable under the pelvis, so that the bedpan may be used without moving the patient. (For the treatment of bedsores, see Vol. I., Ch. VII.) If he has to be turned, the body must be turned as a whole and not twisted from the pelvis. Attention to the bowels will be required, while the bladder also must be watched carefully. While incontinence is present catheterisation will be necessary, and the greatest care must be taken here in asepsis on account of the grave risks of infection. The penis must be washed most carefully and kept wrapped in a dry, sterile dressing, while only soft rubber catheters should be used, the catheters being carefully sterilised and urotropin and acid sodium phosphate administered. In order to avoid infection, some authorities urge that the bladder should be allowed to fill up and drain itself by overflow into sterile flasks, while some have urged that the bladder should be emptied by expressing its contents. Suprapubic cystotomy is advisable when complete retention is present, and then the bladder can be irrigated daily through the urethra. Inasmuch as the patient is anæsthetic, no anæsthesia will be needed for the operation. If cystitis and septic infections of the kidney unfortunately should supervene, they should be treated by the methods described in Chapter XX.

Dislocations of the Spine. Dislocations of the spine can occur only in the cervical region. Here the articular processes are able to slide upon each other comparatively easily as their surfaces are more or less horizontal, but in the other parts of the spine these articular surfaces are practically vertical, so that a dislocation cannot occur without the bones giving way. As in the case of fractures, dislocations may be complete or incomplete.

(A) **Complete Dislocations.** Complete dislocations involve the articular processes of both sides of the column, so that the column as a whole has its continuity broken and marked displacement between the vertebral bodies occurs, while the intervertebral disc is separated. This accident is rare and is chiefly seen in the lower cervical region, where it is usually accompanied by a complete crushing of the cord. Occasionally it has occurred between the occiput and the atlas and between the atlas and the axis (see p. 128), where it is usually the result of hanging or lifting children by the head. Instant death frequently follows this condition. A complete bilateral dislocation is occasionally seen lower in the cervical spine, and here the lesion of the cord, though usually complete, may be partial occasionally owing to the large size of the cervical spinal canal.

In all cases of complete double dislocation of the spine marked pain, tenderness and bruising are present, while there will be great rigidity, the head being held stiffly. There is no lateral displacement or lateral twisting, but a forward displacement of the upper segment of the column will be detected by examining either the spinous processes at the back or the bodies of the cervical vertebræ through the pharynx.

(B) **Incomplete Dislocations.** Incomplete dislocations, or isolated dislocations of individual articular processes of one side of the column only, are more common. They also are chiefly seen in the cervical region, and especially between the fifth and sixth cervical vertebræ. The dislocation is unilateral and is the result of forcible flexion and rotation of the head and neck, frequently caused by a fall upon the head. The articular process of the upper vertebra slips forward over the front edge of that of the lower vertebra and becomes caught there, so that it lies in front of the lower one without being able to slip back. Occasionally a less complete form of dislocation is seen where the upper process does not pass right to the front of the lower one, but slides half over it and hitches there, poised as it were upon a pinnacle.

Clinical Features. Pain and tenderness are often less marked than in cases of simple sprain, as here the ligaments are completely torn and not stretched. The condition is frequently noticed only some time after the accident, when it will be found that the head is flexed to the opposite shoulder so that the ear on the dislocated side is raised, while the face is also turned to the opposite side. The transverse processes and bodies of the vertebra dislocated may be palpated in the neck or pharynx. The head is held rigidly in this position, which is that of an ordinary torticollis, except that the head is flexed in the opposite way, while attempted movements are painful and tenderness may be most marked on the side that is not dislocated, as the ligaments there are stretched and taut. The cord is always uninjured, but there may be tingling and radiating pains due to pressure upon or stretching of the nerve roots as they emerge. The bony points will be very difficult to palpate in a thick neck, but an X-ray plate always will show the displacement.

Treatment. If possible, reduction should be attempted at once before adhesions are formed, which will tend to keep the vertebræ in their displaced positions. An anæsthetic is given, the body is fixed, and traction made upon the head and neck in a direction towards the dislocated side, so as to exaggerate the abnormal attitude. Forcible movement towards the opposite side, with rotation, is then made, and the dislocation probably will be reduced with a snap. In the partial cases, when the articular processes are poised upon each other, the condition usually reduces itself as soon as the patient is anæsthetised. In old-standing cases reduction will be impossible, and then operation may be necessary to relieve pressure upon the nerve roots. In most cases of double complete dislocation treatment is of little avail as the cord is completely damaged, but if the lesion of the cord appears to be a partial one, reduction of the dislocation by traction on the neck must be attempted carefully. This will be rendered easier by first overflexing the head. If this fails a laminectomy or attempt at reduction by means of an open operation will be necessary.

Penetrating Wounds of the Spine. These are really compound fractures of the spine, and being due to stabs or gunshot wounds, are common in war and rare in civil practice. They are frequently accompanied by injuries of the pleural and peritoneal cavities and their contained viscera, or of big vessels such as the vertebral artery. Here again the whole picture is concerned with the extent and nature of the damage to the cord, whilst there is also the added risk of infection setting in within the meninges. Partial lesions of the cord are far more common than in the case of ordinary fractures and fracture-dislocations of the spine. Thus the signs and symptoms of total transverse lesion, partial lesions or Brown-Séquard lesions will be present, while in other instances the cord will escape entirely and the damage be confined to the nerve roots or the cauda equina. In addition to this there may be a continual escape of cerebrospinal fluid if the dura is opened, which in itself may be serious or fatal, while a diffuse septic spinal meningitis is very likely to set in. Fractures of the bones will be present also, while it is not infrequent to find the cord compressed by depressed bony fragments or blood clot.

Treatment. Operation is here the rule; the wound must be thoroughly explored and damaged tissues, fragments of bone and foreign bodies removed. Bony fragments driven in upon the cord, such as laminæ and spinous processes, must be elevated. If the dura is unopened no attempt must be made to open it, while any attempt at suture of the spinal cord itself is utterly useless. In the cauda equina, however, divided nerve trunks must be sutured after enlarging the wound. At the end of the operation the dura should be sutured and the wound closed, if possible, without drainage: the patient is kept for the next week in the prone position, with the head lowered to prevent escape of cerebrospinal fluid. Urotropin with acid sodium phosphate must be administered in large doses—*i.e.*, grs. xv. t.d.s. p.c., and sulphanilamides are of value.

Traumatic Spondylitis. This is a condition which may follow upon cases of severe injury to the back. In most cases no fracture has been diagnosed at the time of the accident, but it is thought that generally the condition is the result of an unrecognised compression-fracture of the vertebral bodies, where excessive callus has been thrown out and softening has occurred both in the callus and the bones around the fracture, as the result of insufficient rest. Some time after the injury the patient begins to complain of pains in the back, body and legs, while a marked projection appears in the back, which may involve several vertebræ, the projection being tender and the muscles hard and rigid on either side of it. The X-ray picture will show an alteration in the shape of the bones with an excessive formation of new bone. After a time the pain ceases, the softening stops and the vertebræ concerned become firmly fused together so that the particular segment of the spine is left deformed and in a state of bony ankylosis. The patient should be kept absolutely at rest in a hyper-extended position for about eight weeks, or until it is thought that bony ankylosis has occurred, and when he first gets up he should wear a supporting jacket.

Kümmell's Disease. This disease, first described by Kümmell, though sometimes also known as König's disease, consists in a delayed crumbling or collapse of the bodies of one or more vertebræ following an injury. It has been regarded as an atypical form of tuberculosis but is probably very much the same condition as the crumbling of bone seen in such conditions as Perthes' disease, Kohler's disease, etc. Pathologically the cause is not known for certain, though the collapse may possibly be due either—

(*a*) To loss of nutrition in the bone, due to the injury affecting the smaller vessels, and causing thrombosis, and giving rise to a rarefying osteitis.

(*b*) To trophic disturbance, following injury to the nerves or spinal cord. The probability is that minute cracks and injuries in the bone and ligaments which give rise to small hæmorrhages are responsible, and that these are accompanied by subdural hæmatomata.

(*c*) It is probable that in some instances an actual fissure is present but is not seen in the X-ray plate. A second X-ray picture may therefore be advisable.

Clinical Features. As a rule after an injury to the spine, often comparatively slight, which may be direct or indirect, the patient complains of bruising, pain and aching. Signs of slight injury to the cord may or may not be present. After a time most of these early symptoms disappear, and the patient apparently becomes well for a variable period. This quiescent or latent period lasts sometimes weeks and sometimes years, and then the pain returns and a marked kyphotic deformity is seen. Occasionally further cord symptoms supervene. The condition is progressive and may ultimately lead to complete disintegration of the cord, but on the other hand, if properly treated, it can be arrested. The X-ray film shows a crumbling of one or more vertebral bodies, especially of their anterior portions, so that they tend to become wedge-shaped and produce a kyphosis. The differential diagnosis may be difficult, as Pott's disease, neurasthenic conditions, osteoarthritis and other forms of spondylitis have to be considered. Abscess formation does not occur.

Treatment. The spine must be put completely at rest and pressure on the bodies relieved in order that ankylosis and union by callus may occur. Thus extension on a frame or a plaster bed is useful and a supporting jacket applied with the spine in extension will have to be worn for a long time. Bone grafts have occasionally been used. The ultimate prognosis is good as the spine becomes strong and useful, though this is not likely to occur for at least two years.

DISEASES OF THE SPINE AND SPINAL CORD

Congenital Deformities. Congenital lesions due to lack of bony development are seen in the spine, which are very similar to those which occur in the skull.

Spina Bifida. The spinal cord is developed by an ingrowth of the epiblast, which commences as a groove in the posterior midline of the body (the neural groove); the edges of this grow up and join so as to give rise to a longitudinal tube lined with epithelium and ultimately forming the central canal. Mesoblastic elements from which the membranes, vertebræ and muscles are ultimately developed then grow round this tube and separate it from the overlying epiblast, whilst in these tissues the vertebræ undergo ossification from three centres, one for the body, and one for each side of the neural arch, there being also epiphyses for the transverse and spinous processes and for the plates forming the top and bottom of the body.

FIG. 30. Lumbar meningocele.

Spina bifida is a congenital defect in the neural arches of certain vertebræ, so that the contents of the spinal canal can protrude under the skin, and is due to an error in development whereby at some part of the spine the primary medullary or neural groove fails to close and the mesoblast to grow in to form the neural arch. In some cases there is a similar defect in the membranes and spinal cord itself. Both laminæ and spinous processes are usually absent, and the defect usually involves several vertebræ in succession. The condition is common (about 1 in 1,000 births); it is most usually seen in the lumbar and sacral regions, but is by no means unknown in the cervical and dorsal regions, and is often accompanied by other congenital deformities, such as talipes, cleft palate, microcephaly, hare lip, webbed fingers, and hydrocephalus. Four varieties are usually described:—

(1) **Meningocele.** This is the least serious form and is usually in the lumbosacral region; it is a protrusion of the membranes only, containing cerebrospinal fluid, through the gap in the vertebral laminæ; the spinal

cord and nerves lie in their ordinary position. Three or four vertebræ are usually involved in this variety.

(2) **Meningomyelocele.** This is the commonest form seen. Here, in addition to the meninges, the protrusion contains the spinal cord, or more commonly the nerves of the cauda equina, which pass down the posterior aspect of the protruding cavity adherent to and just under the skin and floating as it were upon the cerebrospinal fluid.

(3) **Syringomyelocele.** This form usually occurs in the cervical or dorsal region, and here the central canal of the spinal cord is greatly dilated; the posterior part of the cord lies in the bulge and is adherent to the skin and meninges, while the anterior portion is more or less in its normal situation. The greater part of the cerebrospinal fluid is here within the cord.

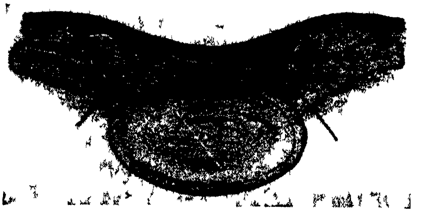

Fig 31 Diagram of a myelocele

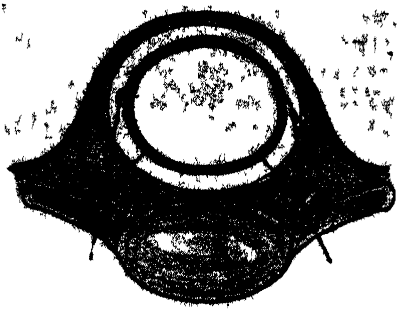

Fig 32 Diagram of a syringomyelocele.

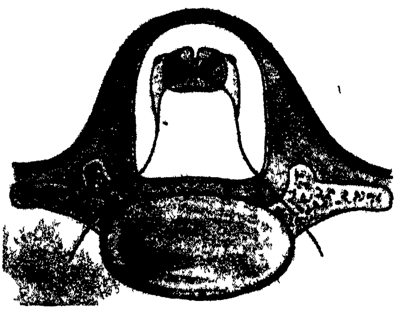

Fig. 33. Diagram of a meningomyelocele.

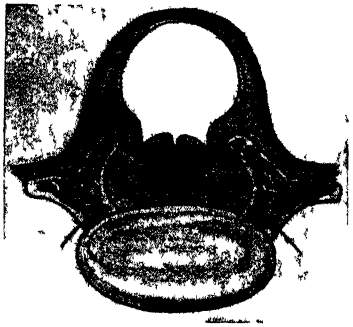

Fig 34. Diagram of a meningocele.

(4) **Myelocele.** This variety is different from the others in that, as well as the vertebral arches, muscles, and membranes being absent, the skin is also undeveloped. Thus the cord lies exposed to the surface without any covering and appears as a raw, red surface, formed by the spread-out structures of the cord, at the upper part of which the central canal opens These cases cannot survive, and the child is either stillborn or dies within a few days. This is probably actually the commonest form, though it is not often seen by the surgeon, and is most frequent in the lumbosacral region.

In the first three forms of the condition the protrusion will be either covered by healthy skin or by a smooth, translucent membrane, which sometimes quickly sloughs or ulcerates, in which case the cerebrospinal fluid escapes, infection sets in and the child dies. Trophic phenomena and paralyses in the legs and interference with the function of the bladder are common in all these varieties except the meningocele.

Clinical Features. With the exception of the myelocele this condition gives rise to a swelling in the midline of the back, usually in the lower half and present at birth. The swelling fluctuates and has a distinct impulse when the child coughs, cries or strains, while in some instances it is partially compressible, its diminution in size being accompanied by bulging of the anterior fontanelle. The skin over the swelling may be normal, but sometimes shows an abnormal growth of hair and is often adherent, thin and translucent. Occasionally it is næviform. The edges of the defect in the bones at the back of the vertebral column can be felt sometimes, and the gap certainly will show in an X-ray plate, while the tumour may be either pedunculated or sessile. If a pure meningocele, it will be translucent; a meningomyelocele will show the shadows of the cord and nerves when this test is applied, while the nerve roots sometimes may be palpated. In some instances there is a dimpling or puckering of the skin at the apex of the swelling, to which the spinal cord will be attached. The myelocele gives rise to a red, raw area in the lumbar region, with the opening of the central canal visible at its upper end, while the child will not live long. In most cases, except in the pure meningocele, interference with the nervous system is present, unless the lesion is very low in the lumbosacral region. These nervous phenomena take the form of paralyses of the legs, talipes, perforating ulcers and other trophic changes, ankylosis of the joints of the foot, and interference with the function of the bladder and rectum; these nervous symptoms do not always appear until the child is a few years old. The prognosis depends very largely on the nature of the skin overlying the lesion, as if this is thin it is likely to give way and death will then occur rapidly from escape of cerebrospinal fluid and meningitis. Thus comparatively few cases live to the age of four or five years, while even in instances where the spina bifida is small and the skin over it thick and healthy, the trophic and paralytic phenomena may persist or supervene later and give rise to great disability. Occasionally masses of nævoid tissue will develop in or around the swelling. A few cases, where the aperture leading into the spinal canal is very small, have undergone spontaneous cure.

Treatment. Whereas some cases merit the name of acute spina bifida as they are on the point of rupturing, and treatment is urgently required to prevent this, other cases are best left alone. This is especially the case where the sac is large, the bony deficiency big, and the condition not tending to progress or get larger. In this case the swelling should be protected by a suitable cap, or the fluid may be drawn off by a fine needle inserted at the side of the protrusion where the skin is healthy and a pressure bandage applied. Sometimes this procedure frequently repeated has led to a cure. The old-fashioned method of injecting Morton's fluid after a small quantity of cerebrospinal fluid has been withdrawn is dangerous and unsatisfactory.

Operation is useless in myeloceles and syringomyeloceles, but it may be undertaken in the case of pure meningoceles and meningomyeloceles if the child seems otherwise healthy, and in cases where the swelling is increasing and rupture is imminent. The immediate results are often satisfactory, though the child usually ultimately dies of hydrocephalus or other complications. If the lesion is above the first lumbar vertebra there is no prospect of paralytic symptoms improving, but if below this point the cord itself may not be involved and improvement is possible in the neurological symptoms if the operation is successfully performed. The presence of hydrocephalus is a contra-indication to operation. Before operation several days must be spent in getting the skin over the swelling clean and healthy. The child must be operated upon with the head low, so that the cerebrospinal fluid does not run out; an elliptical incision is made round both sides of the sac, the protruding membranes are cut away and the opening in them ligatured or stitched over, great care being taken not to damage the nerve roots or cord. The muscles at the side of the spine are then sutured together over the aperture, the skin incision closed, any redundant skin being excised. If the spinal cord is found to be attached to the skin it is better to leave it attached to a small portion of the integument and draw the membranes and muscles together over the cord with its superjacent strip of skin.

Spina Bifida Occulta. In this condition some of the vertebral arches are absent, but there is no protrusion of the membranes or spinal contents. The overlying skin is usually thick, puckered and adherent, and sometimes has an excessive growth of coarse hair at the spot. In other cases there is a deposit over the aperture of a mass of coarse fibrolipomatous tissue, which is sometimes pedunculated and resembles a tail. The condition is usually seen at the lower part of the spine, and is occasionally associated with interference with the cord or nerves, giving rise to talipes, trophic disturbances, anæsthesia, and interference with the bladder and rectum, particularly nocturnal enuresis and lack of sphincter control; sometimes actual paraplegia is present. In most cases these symptoms are due to a mass of fibrolipomatous scar tissue stretching from the skin to the spinal cord; as the child grows this scar tissue drags upon the cord, and the symptoms arise in this way.

If no nervous symptoms are present no treatment is required, but when any nervous affection is discovered an exploratory operation should be undertaken, as a removal of this mass of fibrous tissue and setting free of the spinal cord and nerve roots often will cause great improvement.

Sacrococcygeal Sinus [Pilonidal Sinus]. A small dimple in the skin (post-anal dimple), sometimes deep enough to form an actual sinus, is occasionally seen over the coccyx or lower end of the sacrum. This is due to the remnants of the embryological structure known as the neurenteric canal, which may cause traction upon the skin at this point, when retrogression of the remnants of the tail occurs: such sinuses sometimes will be very deep and lined with squamous epithelium or skin containing sweat and sebaceous glands; pain is present in and round them; they are most common in the upper half of the cleft and on the left side; in many cases multiple skin openings are present usually placed one above the other. It must be remembered, however, that sinuses in this situation are not infrequently due to the bursting of cold abscesses, sebaceous cysts, suppuration in a hæmatoma following a fall, or dermoid cysts, in which case also they will persist for years. Very occasionally a complete fistula communicating with the vertebral canal will be seen (sacrococcygeal fistula); this is incompatible with life.

Sinuses of this kind are liable to repeated attacks of inflammation and abscess formation: they often will give rise to a profuse foul discharge from the decomposition of secretions, and therefore are mistaken sometimes for fistula-in-ano. In order to cure them they must be dissected out completely, the wound being left open and allowed to granulate, as healing by first intention cannot be expected.

Congenital Sacrococcygeal Tumours. Many forms of congenital tumour are met with in this situation, some of them being connected with the embryological neurenteric canal or the post-anal gut. The following varieties will be seen :—

(*a*) The congenital lipoma, sometimes associated with a spina bifida occulta, and resembling a tail. This is easily removed.

(*b*) Cystic hygroma, which is a flaccid, soft, fluid swelling with the same characteristics as those seen in the neck (see p. 401). Possibly some of these are due to meningoceles which have been cut off from the spine by closure of the bony aperture.

(*c*) Lymphangioma, sarcoma and dermoid cysts are common here. The last are sometimes found lying between the rectum and the coccyx, and may project or burst either externally or into the rectum, in which case hair may pass out of the anus.

(*d*) Tumours of bigerminal origin (teratomata) are also seen here. They have the same characteristics as those met with elsewhere.

(*e*) Very rarely congenital adenomata occur, probably arising in the post-anal gut. These are typical alveoli-containing adenomata and are quite innocent.

(*f*) The so-called chordoma which arises in remnants of the notochord (see p. 135).

(*g*) Gliomata and endotheliomata are also seen.

All these conditions present themselves as slow-growing swellings in the sacrococcygeal region, and exhibit various degrees of fixity, fluctuation, etc.

Treatment. The treatment of all these conditions consists in their removal, if it be possible. These operations may be very difficult, as the swellings often extend into the hollow of the sacrum, and may involve the rectum, while certain of the cystic conditions will be found quite unexpectedly to communicate with the spinal canal. There is thus considerable risk of infection, and the operation is by no means free from risk, especially in young children.

INFLAMMATORY DISEASES OF THE SPINE

Acute Osteitis. This is a rare condition which occurs in young people. It is due to a blood-borne infection, usually by staphylococci, and similar to that which occurs in the case of other bones (see Vol. I., Ch. XVIII.) ; it is most commonly seen in the cervical or lumbar portions, *i.e.*, the most mobile portions of the spine, where it may commence either under the epiphyseal lines of the bodies or in the arches. It gives rise to high temperature, general malaise, rigors, and intense pain and rigidity, localised to one portion of the spine, with gross constitutional disturbance. Rapid necrosis of bone occurs, but there is no deformity, as the process is too rapid. Pus will form very soon, though the abscesses will not be detected easily unless they track into the psoas sheath and cause flexion of the hip ; the prognosis is very bad, as infection is very liable to involve the meninges and cord, especially if the spinal arches are infected. A less severe form is sometimes seen, in which the process is more of a periostitis, and here the prognosis is better.

The best treatment consists in early operation to let out the pus, if it can be found, while an extension is applied to the spine, the patient being kept at absolute rest in the recumbent position, and general measures to combat the infection persisted in. Expectant treatment has been adopted successfully in some cases. Should the patient survive, which is unusual, one or more sequestra will form and have to be removed. This can be done easily in the case of the vertebral arches or the bodies in the lumbar and cervical regions ;

in the dorsal region the operation of costotransversectomy will be required (see p. 130).

Typhoid Spine. This is a rare condition seen during the later stages or during convalescence from typhoid fever. At one time it was thought to be hysterical or rheumatic in origin, but there is no doubt that it is actually due to an acute typhoid infection of the bones and ligaments of the spine similar to that seen in other bones (see Vol. I., Ch. XVIII.). The lumbar region is usually involved, and the disease sets in suddenly with marked rise of temperature and intense pain, rigidity and tenderness over the affected vertebræ ; there is no deformity. After a few days an X-ray photograph will show caries of the bones, and later on new bone formation, leading to ankylosis ; the meninges occasionally become involved secondarily. The condition will resemble closely an acute osteitis of the spine, but is considerably less acute ; it may also resemble spondylitis deformans.

Treatment. The spine must be immobilised and the patient kept flat, and in some cases the inflammation will settle down. Suppuration, however, not infrequently occurs, and then abscesses will require evacuating. The prognosis is good.

Gonococcal fasciitis is seen not infrequently in young adults (Vol. I., Ch. XIII.) and has a sudden onset with acute pain, ankylosis is the usual result with a rigid spine " poker back. A somewhat similar condition of *absorptive spondylitis* is seen in young adults, it is liable to recurrence and is possibly of undetected gonococcal origin.

Treatment in both cases consists of immobilisation of the spine.

Actinomycosis, Hydatid Cysts and Gonorrhœal Rheumatism occasionally occur in the spine. They have the same features as elsewhere and may closely resemble Pott's disease.

Actinomycosis may attack the spine and surrounding structures rarely ; sinuses soon develop and the characteristic sulphur granules are found in the pus.

Syphilitic Spondylitis. Gummatous disease of the vertebræ is a very rare condition which is seen in adults as the result of acquired syphilis, and is usually found in the cervical region, where it appears either as a diffuse gummatous periostitis of the fronts of the bodies of the vertebræ, or else in the form of localised gummata in the bones. It may resemble Pott's disease, but is considerably more rapid, the bone being extensively destroyed, with much deformity, suppuration being rare. There is severe pain, especially at night, while rigidity and angular deformity rapidly develop. Other signs of syphilis and a positive Wassermann reaction will be present. Cases have been described in which portions of bone have sloughed through into the pharynx and been spat out. The treatment consists in general antisyphilitic measures together with local treatment similar to that of Pott's disease (see below).

TUBERCULOUS DISEASE OF THE SPINE—POTT'S DISEASE (SPINAL CARIES)

This is a common condition which gives rise to erosion and destruction of the vertebræ, and is known to be due to tuberculosis, the organisms reaching the vertebral column by the blood stream. It is commonly seen in children under ten, and is rare over the age of thirty-five ; no age is, however, exempt. It is equally common in either sex, and though any part of the spinal column may be attacked it is most usually seen in the dorsal and dorsilumbar region ;

the cervical region is rarely involved except in children. A history of a previous injury is often given, and in some cases this is probably responsible in that it causes a lowering of resistance locally; it must be remembered that in all cases the tubercle bacilli are already present in the patient's system, and that probably some other local focus is in existence. There is frequently a family history of tuberculosis, but it is not at present known whether the actual infection is more commonly of the bovine type (and therefore food-borne) or of the human variety.

Morbid Anatomy. Two forms of infection are seen, the disease commencing either as a periostitis or as an osteitis.

(*a*) The *periosteal form* is usually seen in adults, where it begins under the periosteum of the bodies of the vertebræ, usually on the anterior aspect, whence it spreads round the bones and up and down to the neighbouring vertebræ, causing the bone to crumble away and the intervertebral discs to be destroyed. This form does not lead to deep destruction of the vertebral bodies, and there is, therefore, no very marked angular deformity. Tuberculous pus collects under the periosteum, and especially under the anterior common ligament, so that ultimately large abscesses, full of pus, débris and granulation tissue, will be formed, while the liability to pressure upon the spinal cord is correspondingly great (see p. 121).

(*b*) The *osteitic type* is more common, and is that seen in children invariably. Here the tubercle is deposited in the cancellous bone of the vertebral bodies in the neighbourhood of their disc-like epiphyses, with the result that the marrow becomes infiltrated and the affected vertebral bodies crumbling and softened (tuberculous caries, see Vol. I., Ch. XVIII.). The anterior portions of the bodies are chiefly affected; thus angular deformity is common and pressure upon the cord rare, in contrast to what obtains in the periosteal form, in which, as a result of the disease in the neighbourhood of the anterior and posterior common ligaments, the cord soon may get pressed upon. Caseation and suppuration occur and the neighbouring discs and vertebræ become involved. In other instances the disease extends widely under the anterior common ligament, involving many vertebral bodies. The pus frequently works its way to the fronts and sides of the vertebral bodies, forming localised abscesses, which are prominent and important features in this disease (see p. 121).

The weight of the trunk above the lesion and the action of the spinal muscles soon produce marked deformity. As the anterior portions of the bodies are destroyed the bodies crumble and sink in, but the intact vertebral arches and articular processes prevent a dislocation of the spinal column; thus there is no bony pressure upon the cord, but a marked angular deformity is produced, the spinous processes projecting backwards to form a prominence (kyphosis). If only two or three vertebral bodies are affected, the deformity will consist in a sharp angle, but in the more diffused cases, where many vertebræ are involved, the deformity becomes a more gradual backward curve. It will be seen also that the more extensive the destruction of bone is the larger the bony spinal canal will become, while no degree of angular deformity by itself will produce pressure upon the cord. Lateral curvature is unusual in caries of the spine; if it occurs it is never very severe. The vertebral column above and below a marked kyphosis endeavours to produce compensation and maintain the body erect by undergoing a considerable degree of lordosis.

In some instances, and especially in the lumbar region, the disease appears to start simultaneously in several bodies, which become pitted, worm-eaten and carious, but do not crumble or collapse. In this case a considerable amount of new bone may be thrown out and limit the disease, especially if septic infection has occurred down sinuses, while it is not unusual for moderately large sequestra to form, especially in adults. These cases are accompanied by little or no deformity beyond a slight flattening of the normal lumbar curve.

In other and very rare cases the bodies are not affected at all and the disease remains confined for some time to the spinous or articular processes or the laminæ; here it is of a less serious type and gives rise to far less definite signs and symptoms.

In many cases the disease is arrested and becomes quiescent, this cure occasionally being spontaneous, but more frequently the result of treatment. This process is brought about by the transformation of rarefied bone and granulation tissue into fibrous tissue, with the result that the affected vertebral bodies become ankylosed, the ankylosis at first being fibrous, but later becoming osseous; so that ultimately complete fusion between the vertebral bodies, spines and laminæ will occur, abscesses drying up and the bones becoming sclerosed and dense, and the amount of deformity (which will persist permanently in the form of a "hunchback") depending on the efficiency of the previous treatment with regard to the prevention of kyphosis. During this process of healing, and before the ankylosis has become bony, the contraction of fibrous scar tissue sometimes will give rise to considerable increase in deformity, which is undesirable though not necessarily a bad sign.

Abscess formation is a common condition in this disease, though it will not necessarily occur in every case. The situation of these abscesses and the direction in which they extend depend upon the situation and level of the disease, and they will be referred to later more fully. When, however, the tuberculous process spreads round the back of the bodies of the vertebræ to the neighbourhood of the posterior common ligament, an abscess full of pus, débris and granulation tissue will arise within the spinal canal, and will give rise probably to pressure upon the spinal cord. This is the most usual cause of nervous symptoms in the disease. In other cases the spinal pressure may be produced by œdema or thickening of the membranes (tuberculous pachymeningitis), while rarely the pressure is the result of the displacement of a sequestrum or a sudden dislocation of the column as a whole as a result of extensive bony destruction. These last two conditions are rare and are seen only in the cervical region. Mere gross angulation of the spine never produces pressure symptoms by itself.

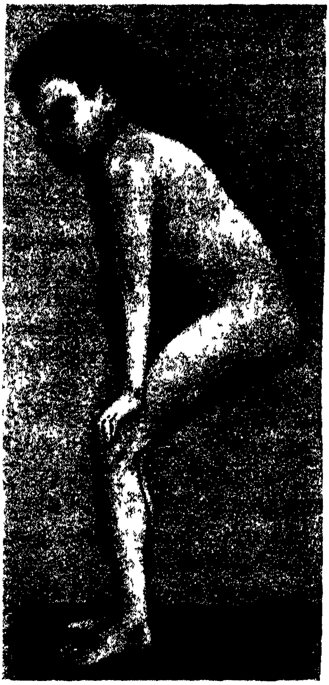

FIG. 35. Advanced Pott's disease in the lumbar region.

In other instances further and more severe nervous symptoms will be due to a definite transverse myelitis, which sets in in the cord as a result of interference with its blood supply by the tuberculous disease and the meningeal sclerosis near by. These changes in the substance of the cord may be either toxic or vascular in origin. There is frequently a considerable amount of vascular engagement of the cord for some little distance below the main centre of infection, which is probably due to pressure on the veins by œdema and tuberculous granulation tissue. When the processes of repair and healing are setting in the cord will sometimes be strangled by the formation of fibrous tissue.

Clinical Features. The clinical aspect of Pott's disease will be found to vary greatly in different portions of the spine, although certain general features are common to all cases. It will be found also that the diagnosis in many instances is greatly assisted by the onset of certain symptoms which are due not so much to the actual disease itself as to some of its complications.

Often the earliest sign is an awkward gait, with a marked tendency to tire easily, and this may exist some weeks before the onset of the more classical symptoms and signs enumerated below.

(*a*) *Pain.* This is a symptom which is very seldom absent, and it is usually found in the earliest stages, when it takes the form of a dull aching or a feeling of weakness or tiredness. Later on in the condition the pain becomes of two definite types: (1) Local pain occurs in the form of a dull aching at the site of the disease, constant, increased by movement, and especially by jarring or jolting the spine in such actions as jumping and landing on the heels or blows on the head or shoulders. Pressure or percussion over the site of the disease also will be painful. Occasionally the patient complains that his back is breaking, and children cease to play and sit or lie about, very often taking up abnormal attitudes which can be seen to take the weight off the spine as far as possible, while the pain is usually worse when up and about than when in bed at night. (2) Referred pain is due to irritation of emerging nerve roots, when it will be referred along the course of the nerves concerned. Its situation, therefore, will depend upon the site of the disease, and it may be referred down the legs, into the buttock or lower abdomen, in the epigastrium, when it may be described by children as the " stomach ache," or in other cases it may be a girdle pain, a headache, or a neuralgia of the arms.

As the disease is frequently seen in small children, they cannot give an account of their symptoms, and special attention therefore must be paid to tender spots, abnormal attitudes and postures (see p. 128), and such indirect evidence as sharp cries during sleep.

(*b*) *Rigidity.* This is usually marked, and is due to a reflex contraction of the muscles at the sides of the spinal segments affected, which is primarily of a protective nature and similar to that encountered in disease of other joints. The affected portion of the spine is held stiff and rigid, and if the palm of the hand or the tips of the fingers are held upon it while the patient attempts to stoop, twist or turn, it will be found that several vertebræ move together as a mass without any separate movements between their individual spines, while the muscles on either side can be felt to be hard and stiff. Such rigidity is far easier to detect in the lumbar than in the dorsal region. If left to himself and asked to pick up something from the floor the patient may refuse to bend his back, but squats down into a semi-sitting position, bending his hips and his knees and keeping his spine vertical; he will then stand up again by pushing his body up by the pressure of his hands upon his knees. If a child with spinal caries is laid upon his face upon a couch and his heels moved from side to side, and also lifted off the couch, dorsiflexion and lateral mobility will be found to be greatly limited throughout that section of the spine which is involved.

In the early and middle stages of the disease this rigidity is due entirely to muscle spasm and is strong evidence of activity of the infection, but it must be remembered that in the late stages the bones will be firmly ankylosed and all movements of the affected segment lost. Thus rigidity of a different kind will then be present, but this latter type can be distinguished from the former by the fact that the muscles are soft and no longer held in spasm.

(*c*) *Deformity.* This is an important sign, but it must not be regarded as an early feature, as it sets in only when considerable bony destruction has occurred. It nearly always takes the form of an anteroposterior curve, convex backwards (kyphosis), but lateral deviations occasionally will be seen either as the result of unequal muscular spasm or from one side of the vertebral bodies being more extensively diseased than the other. The amount and acuteness of the bend depend upon the situation of the disease and upon the number of vertebræ involved. If the bodies of one or two vertebræ only are involved, there will be a sharp angular deformity, with compensatory curves of the spine above and below to enable the patient to stand upright, while if several vertebral bodies are affected the curve will not be angular, but longer and wider, though it ultimately may become very acute as the bodies are completely destroyed. Deformity is completely absent in those cases where the disease is confined to the spinous or transverse processes, and is much less marked when the infection is primarily a periosteal one.

Secondary changes as the result of the deformity are common. Thus if there is a dorsal kyphosis, the shape of the thorax is altered, the sternum becoming bent and the ribs crowded together, and the abdomen pot-bellied, while in lumbar disease the angle between the pelvis and the spine may be altered, with the result that secondary deformities may be set up in the legs and feet.

(*d*) *Abscess.* This is a serious result of spinal disease which is more common in adults than in children. A spinal abscess of this kind, starting as it does very deeply, is often not recognised for some time, though if on account of its bursting, or for other reasons, it becomes secondarily invaded by septic organisms, a grave element, with risk to life, is at once introduced. Such an abscess usually commences in front of the vertebral bodies ; sooner or later it will perforate the anterior common ligament and will track in various directions, according to the portion of the spine where it has arisen (see p. 127). These abscesses give rise to few recognisable symptoms other than a swelling and possibly pressure effects. They cause no leucocytosis and no constitutional disturbance, apart from the small rise of temperature that is very commonly associated with the spinal caries itself ; nor do they cause any pain apart from that of the bone disease until they approach the surface. In this latter case the skin and the soft structures underneath it will be stretched and infiltrated and then pain will become more noticeable. It is not unusual for the appearance of a cold abscess in some situation not far from the spine to be the first thing noticed ; in every cold abscess reasonably near the spine the possibility of spinal caries, therefore, must be remembered.

(*e*) *Nervous symptoms* are by no means uncommon in this disease, occurring in about 8 per cent. of cases, especially those which are advanced or neglected, though at times they will be seen in quite early cases. Their pathology is described on p. 119, and they are due in most cases to direct pressure upon the cord. This pressure nearly always commences at the front of the cord, for it is due to extension of the disease from the vertebral bodies; and thus it will be seen that the parts of the nervous system first affected will be the motor tracks, for these are the most sensitive tracks and lie in the anterolateral parts of the cord. When fully developed the condition takes the form of a true spastic paraplegia, commencing with dragging or shuffling of the feet and weakness of the muscles supplied by the cord below the seat of the disease, with brisk knee jerks, ankle and patellar clonus and extensor plantar responses, while incontinence of urine and fæces is sometimes found. These phenomena usually come on slowly unless due to a sudden bony displacement (see p. 119), while after a time the muscles waste from disuse, and as the result of descending degenerations of the cord contractions and deformities will set in. Sensory changes only occur in severe cases, but when seen they are usually accompanied by incontinence of urine, incontinence of fæces and bedsores, while if anæsthesia is present, the muscular paralysis is usually flaccid with diminished reflexes, this showing that the pressure on the cord is much more intense.

In those cases where sensory changes, especially complete anæsthesia and dissociation of sensation, are present, it is probable that the condition is more than a simple pressure paraplegia, and that an actual myelitis has supervened. Compression paraplegia and symptoms referable to actual pressure upon the cord are seen most commonly in the mid-dorsal region.

In other cases nervous symptoms will be due to pressure upon the nerve roots where they pass out through the spinal foramina. The symptoms then take the form first of pain and hyperæsthesia, along the course of the nerve involved, girdle pain and other referred pain being common, while if the pressure becomes more severe anæsthesia will supervene and weakness, paralysis and wasting of the muscles supplied by the nerves concerned, the paralysis then being of the lower motor neurone type.

Spinal caries is sometimes seen in the upper cervical region, involving the atlas and axis vertebræ, and here it commences usually in the articulations at the side of the vertebræ rather than in the small vertebral bodies. When this is so it occasionally happens that, as the result of slight movements or injuries, a sudden displacement of the vertebræ one upon the other may occur, leading to damage of the upper part of the cervical cord and instantaneous death. The odontoid process sometimes becomes detached as the result of caries, and this leads to the same result, if the atlas slides forward upon the axis.

(*f*) *X-ray Appearances.* A good X-ray photograph usually affords valuable evidence in connection with this disease, both as regards its site, nature and extent. As the bodies of the vertebræ are chiefly affected, it is probable that a lateral view will exhibit these better and give more information than an anteroposterior view. In early cases, in the plate, there may be seen clear areas due to carious foci, while in other instances the outlines of the bodies are irregular and blurred. In more advanced conditions the vertebral bodies will be altered in shape, and they may be seen to be collapsed or spaced irregularly. Angular deviation will be seen easily, while abscesses frequently cast a dense shadow which is spherical or spindle-shaped and which, in an anteroposterior view, covers the affected vertebral bodies and also one or two others above and below them. The gradual fusion of the bodies by the formation of new bone as the process of repair occurs will also be seen.

Fever up to 101° or so is sometimes seen in spinal caries in the early stages, but this usually disappears after a few weeks' treatment; in the later stages, if septic infection is superadded, a hectic temperature will become marked.

Course and Prognosis. If untreated the condition usually progresses, pain and deformity increasing and abscesses almost certainly forming, while treatment undertaken early and efficiently offers considerable prospect of a cure, especially in children. If untreated the abscesses tend to spread and burst, in which case septic infection will supervene, chronic discharging sinuses form, and the patient probably will die ultimately of toxæmia, exhaustion or lardaceous disease; while under suitable treatment, consisting of rest and avoidance of infection, the abscesses will disappear as the bone lesion heals, the pus solidifying and finally becoming converted into putty-like tissue, which in its turn organises into fibrous scar tissue.

Paraplegia is a serious complication, but by no means precludes a cure, for as the bony condition becomes quiescent under suitable treatment, the paraplegia will disappear frequently (80 per cent. of cases), sphincter power returning first, sensation next, and finally motor power. In severe cases of paraplegia with spastic flexed legs and where all the tracts of the cord seem to be involved, the prognosis is much worse. There is always a risk of the onset of a diffuse tuberculous meningitis or an acute miliary tuberculosis, while at times other organs, such as the lungs or kidney, will become infected, but luckily all these complications are rare. The prognosis is considerably worse in adults than in children, but in these latter, if properly treated, especially if treated in a special institution other than a general hospital, the chances of cure are very good. Deformity nearly always can be prevented if it is not present when treatment is commenced, while, in some instances, if it has already set in, efficient treatment will get rid of it (see p. 126). Many cases become quiescent permanently, but with a marked hunchback, and it will be found that many of these hunchbacked people are remarkably active and intelligent, which is in accordance with the observed fact that tubercle bacilli at times appear to have a stimulating effect upon the intellect.

When the deformity has set in the diagnosis of this condition is usually easy, though if the deformity is only slight it may possibly resemble a rickety or static bending, or a spinal exostosis: the X-ray appearances and the lack of rigidity should distinguish these conditions. On the other hand, when pain is a prominent feature and no deformity has occurred, lumbago, aneurysm, osteoarthritis, syphilitic spondylitis, intercostal neuralgia, spinal tumours, hysterical spine and even renal conditions may resemble the condition closely, and in this case it often will be found that a diagnosis can be made only either as the result of observing its course or the effects of treatment or by an X-ray examination. Malignant disease of the spine is usually more painful and more rapid; it is generally secondary to some other primary focus elsewhere. Those cases in which the pain is chiefly of a referred nature are frequently misleading, especially if it is referred to the epigastrium or the sciatic nerves. All cases of chronic abdominal pain, or of sciatica in young persons, should have their spines carefully examined. For the differential diagnosis of spinal abscess see pp. 128—133.

Treatment. There are two great essentials in the treatment of this condition, (*a*) first of all general antituberculous measures. These consist in abundant fresh air, and residence in a suitable locality, such as Margate, Bournemouth or the East Coast, Switzerland, or Berck in France, where the climate is dry and bracing. In addition the patient must have plenty of good food, special attention being given to the supply of plenty of fats and such general measures as direct exposure to sunshine, real or artificial, and general tonics to the system. Tuberculin is of very doubtful value. (*b*) Secondly, efficient local treatment of the spine must be given, and this consists in *absolute rest by immobilisation*, with freedom from weight bearing and absence of interosseous pressure between the vertebræ, while measures also will have to be taken to limit or correct the amount of deformity. Thus the patient's spine must be immobilised in a completely recumbent position and in a hyperextended state, until the vertebræ become ankylosed by new bone and the disease is quiescent. This absolute fixity of the spine is difficult to secure, and many methods and splints have been devised for it. Thus immobilisation may be effected as follows :—

(*a*) The application of plaster of Paris in the form of a plaster bed is a valuable method of fixation, and this produces a more perfect immobilisation than any other method. The patient is placed upon the plaster of Paris bed, which is moulded on to him while he lies in the prone position, with considerable hyperextension, and the plaster bed with the patient in it is later placed upon a wooden frame to support it. In adults this may be used as the method of treatment from the commencement of the disease, but in children it is not so suitable in the early stages, as they will not lie still on the bed. Thus in children plaster of Paris is best applied in the later stages when the disease is becoming quiescent, and it is then best used in the form of a complete plaster jacket. Such a plaster of Paris jacket is applied over a woollen jersey or vest and the jacket is moulded accurately round the trunk, while the child is suspended vertically in the air by means of a stand or tripod and string or webbing supports passing round his body, head and armpits, or by means of a Sayre's sling. Room must be left for the distension of the abdomen after meals and the padding must be carefully arranged to protect prominent points. The plaster is then applied in the form of plaster of Paris bandages put on as described in Vol. I., Ch. XIV., the jacket being allowed to dry before the patient's position is moved, and by this means of suspending the child it is found that the vertebral bodies are slightly separated and interosseous pressure prevented. The jacket must be reinforced at the places where extra strength is required, while it may be lightened by cutting out portions where no strain is imposed. In the case of cervical caries (see p. 128) fixation of the head is essential, and here a plaster of Paris must be devised to include and fix the head and shoulders. Various forms of masts and collars have been devised at different times to take the weight of the head off the cervical spine, but none of these have been found to be very efficient.

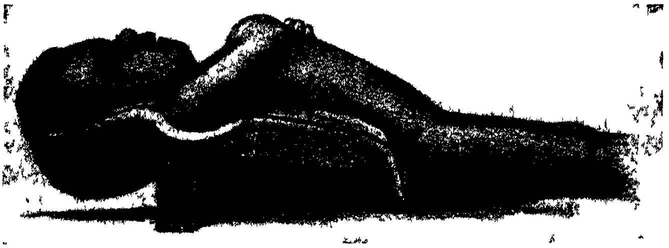

FIG. 36. Plaster of Paris bed for spinal caries.

While the patient is in a splint or plaster and is recumbent, periodic examination must be made, both as to his general condition and also to see that no abscesses are forming in any of the usual sites (see p. 128), and that there are no signs of paraplegia.

(*b*) In disease of the dorsal and lumbar regions excellent immobilisation can be achieved and deformity arrested or prevented by nursing the patient on the face with the chest supported with pillows. The position is soon well tolerated and the back muscles develop and get good tone, acting as a perfect splint, especially if sunlight treatment is used. Cure takes from two to three years, but the results are excellent.

Rollier, at Leysin, places these cases upon their face and gives them judicious sun treatment; he never interferes with abscesses, which he regards as a source of antibodies. Excellent results are obtained in from three to five years, and it is of interest to note that there is no trouble with constipation so long as the patient lies on the abdomen.

(*c*) Immobilisation with hyperextension can be attained more easily, effectively and comfortably by laying the patient upon an apparatus such as a Bradford frame. This frame consists of gas piping and canvas and permits of an extension being applied to the body or the head, enables the patient to be carried or wheeled about, and can be bent to the desired angle of hyperextension. The double Thomas's splint and Gauvain's wheelbarrow splint are somewhat similar contrivances and equally serviceable.

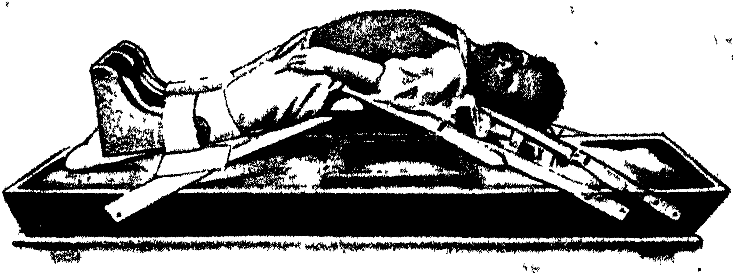

FIG. 37. Splint for spinal caries permitting graduated hyperextension.

(*d*) Phelps' box has been used in the past a great deal in the case of young children. The child is placed in the box, which is carefully padded, and strapped or bandaged there, and in it he can easily be carried out into the fresh air. Extension can be applied, if necessary, and hyperextension also. It is probable, however, that Phelps' box does not secure such good immobilisation of the spine as do other methods. Gauvain's backdoor splint, which is a somewhat similar contrivance, in which a detachable central flap can be removed from the dorsal surface of the apparatus to enable the patient's back to be attended to, also will be found exceedingly useful in children.

This absolute fixation of the spine, to be achieved by one of the above methods, must be continued for a very long time. It must continue till all pain has disappeared for some months, and until there is evidence in the form of complete fixity and lack of movement or from the X-ray appearances that the disease is becoming quiescent and the bones ankylosed. This will take a minimum period of one year at least, and in many cases, especially in adults, two or three years will be required. After this period, when convalescence is commencing and the disease is becoming quiescent, the patient may be allowed gradually to sit up and stand and even walk about, though he must all the time wear a supporting apparatus to prevent movement of and pressure upon the spine. The plaster of Paris jacket described above is an excellent apparatus for this purpose, while other jackets made of poroplastic felt, celluloid, leather or other materials and reinforced by strips of metal are equally serviceable. Various forms of braces have been devised for this purpose. Taylor's brace is an apparatus of this kind, consisting of upright iron bars, placed one on either side of the spine behind, and moulded to fit the body. Supports pass over the tops of the shoulders and over the clavicles, while another metal support runs round the pelvis and rests on the buttocks. The front of the patient's chest and upper abdomen are covered by a firm leather jacket, and the whole apparatus is secured together and fixed by straps and buckles passing over the shoulders, round the sides and between the legs, carefully-fitting pads being provided over the pressure points. One of these forms of fixation apparatus must be worn for at least a year after the patient is up and about, and all signs and symptoms have disappeared, whilst the appearance of any further pain or signs of activity is a signal that recumbency, hyperextension and absolute fixation must be undertaken again for a considerable period.

Correction of Deformity. In many cases where there is a marked angular projection of the spine, this, if recent and not fixed by bony ankylosis, may be corrected gradually by putting the patient into a plaster of Paris jacket with a diamond-shaped aperture cut out of the back of the jacket opposite the summit of the projection. Thick layers of cotton wool are applied through this aperture to press upon the spinal projection and firm bandaging employed to press upon them and force them down upon the spine. The padding is continually renewed and thickened, and by this means the projection can be forced back gradually into place. A similar result may be obtained by placing the patient upon a hyperextension frame and gradually increasing the hyperextension for some weeks, when the spine can be completely straightened in some early cases. No attempts at violent correction of the deformity must be made, as this is very likely to light up the disease.

Attempts have been made to imitate the natural processes of cure and shorten the period of recumbency required to produce ankylosis of the spine by means of operative procedures, devised to secure more or less rapid fixation of the spine. Two operations have been devised to assist and encourage bony fixation of the spine. They are :—

(1) **Albee's Operation,** consisting in the cutting of a large bone graft from the crest of the tibia, splitting the interspinous ligaments and spinous processes of five or six vertebræ at, above and below the diseased segment of the spine, and wedging the graft firmly into these split processes, where it unites and secures fixation of the spine within three months. It must be admitted that this procedure is not always successful and that the graft sometimes comes loose, while it is almost essential to employ an electric circular saw to cut the grafts if it is to be performed properly.

(2) **Hibbs's Operation** consists in exposing, removing the periosteum and fracturing a similar number of spinous processes, and turning them down so that they interlock with one another; callus is then thrown out, and these processes will fuse and ankylose the spinal segments to each other in the course of three months or so.

The presence of spinal abscesses need not be regarded as a contra-indication to the performance of these operations, but if paraplegia is present these operative procedures should not be considered.

Either of these operations must be followed by a period of recumbency with absolute fixation of the spine, similar to that already described above, and this is nearly always best obtained by placing the patient prone upon a plaster bed. The duration of rest and recumbency, however, need not be as long as in the cases treated by conservative measures, and probably a period of six months' recumbency and then one year with a spinal support will suffice. Thus it will be seen that by these methods the total duration of treatment may be diminished considerably (from six months to a year in a successful case), but this is achieved only by means of a somewhat serious operation, and the authors feel that this line of treatment is one only to be undertaken in certain special cases, where, for some reason, the usual conservative methods are unsuitable. Thus children do very well when treated by the ordinary methods, but in the case of adults, in whom the prognosis of conservative treatment is much worse, and to whom prolonged recumbency is far more irksome, the operation is undoubtedly worth considering.

Treatment of Paraplegia. The treatment of this complication is in the first instance that of the spinal caries itself, and it will be found that in most cases, as the spinal condition improves and becomes quiescent under the influence of complete rest, immobilisation and recumbency, the paraplegia gradually will diminish and disappear. A weight extension applied to the legs is perhaps especially useful in this condition, while extra care in the nursing must be taken to prevent bedsores over pressure points. Difficulties of micturition may be present, and these may require regular catheterisation, to be conducted with the strictest possible aseptic precautions, for the risks of septic cystitis and pyelonephritis are equally common and equally grave as in the case of spinal injuries. Cases where the paraplegia is merely due to œdema recover rapidly under this treatment; those where the pressure is due to granulation tissue or abscess formation may take some months to recover. If, however, at the end of six months' rigid treatment of the spine there are no signs of the paraplegia improving, a laminectomy will have to be undertaken to relieve the pressure. Laminectomy in this disease, therefore, should be performed only—

(*a*) If six months' rigid treatment has failed to relieve the paraplegia.

(*b*) When nervous symptoms come on late in the case and are probably due to a development of scar tissue strangulating the cord.

(*c*) When the caries affects chiefly the neural arches or laminæ. It is practically never necessary to perform a laminectomy for this condition in children, as the paraplegia in their case always clears up under rest.

In all these instances a simple decompression of the cord is performed by cutting away the requisite number of spinous processes and laminæ. On no account must the dura mater be opened, as should this occur there will be a grave danger of tuberculous meningitis. In many cases the dura and contained spinal cord can be gently dragged to one side, and any abscess which is pressing upon the front of it can be opened and evacuated thus and the bodies of the vertebræ curetted.

Treatment of Spinal Abscesses. This will be dealt with later in connection with the various regions involved (see below).

CARIES OF THE DIFFERENT SPINAL REGIONS

The foregoing description of Pott's disease applies in general to all the different parts of the spine, but in special segments of the vertebral column certain rather specialised features will occur.

Upper Cervical Region. The first and second cervical vertebræ, including the atlanto-axoid articulations, are not infrequently the seat of caries; there will be loss of the movements of nodding and rotation of the head, while the tendency is for the atlas to slip forwards. If this occurs suddenly, there will be immediate death from the odontoid peg damaging the medulla (see p. 121). More often this displacement occurs gradually, and then it may become quite marked without the cord suffering, and ankylosis and quiescence ultimately occur. In the lower cervical portion pressure upon the cord is rarely seen, as the spinal canal is so wide in this situation. The head and neck are held rigid, and to look round the patient turns his whole body, while children frequently rest their head or chin upon their hands to take the weight off the cervical spine. All movements of the cervical spine are resented and pain is complained of in the neck, down the arms, or up the back of the head. Deformity is not usually marked, though occasionally a marked and fixed wry neck will be seen, with the chin tilted upwards. In most cases the only noticeable deformity is either a diminution of the normal forward convexity or a shortening of the neck, the head dropping nearer to the shoulders and giving rise to a peculiar stunted appearance. This only occurs if several vertebral bodies are affected, as the bodies in this situation are so small.

Should pressure upon the cord occur in this situation, it will resemble in some ways the lesions of the cord described on p. 122, but it comes on gradually, beginning in the arms, and never in any sense resembles a complete transverse lesion. In some cases the condition will resemble closely rheumatic torticollis or osteoarthritis of the cervical spine. These two conditions usually can be distinguished by the history and course and by the X-ray appearances. In other instances a diagnosis will have to be made from inflamed cervical glands with muscular spasm, congenital torticollis, or subluxation of the cervical spine.

Abscesses are common in this situation, and they occur first in the retropharyngeal space between the spine and the prevertebral layer of cervical fascia (**chronic retropharyngeal abscess**). Such an abscess bulges into the pharynx, where it may be seen and felt as a soft, fluctuating swelling, sometimes causing difficulty in swallowing and breathing, and giving rise to snoring or œdema of the glottis. It will burst occasionally into the pharynx, in which case suffocation may ensue in a child, or aspiration-pneumonia may follow, while a mixed septic infection will be set up inevitably and involve the bones of the spine. In other cases the pus tracks to the side of the neck and points under the skin behind the vessels and behind the sternomastoid muscle, in the posterior triangle. Such cervical spinal abscesses have presented themselves occasionally in the suboccipital region, the axilla, the mediastinum or the anterior triangle of the neck, and they have not infrequently been mistaken for glandular abscesses. For the other forms of retropharyngeal abscess see Chapter VIII.

Treatment. The treatment of cervical caries is the treatment of spinal caries in general, while an extension upon the head will usually be required, together with absolute fixation of the head upon the trunk.

Treatment of Retropharyngeal Abscess. The treatment of all spinal abscesses is always difficult, as every precaution must be taken to prevent their becoming infected with septic organisms, as this has grave consequences. Thus these abscesses should never be allowed to burst, nor should they ever be drained. (For their treatment in general see Vol. I., Ch. VI.). In the case of a retropharyngeal abscess, immediate treatment for the abscess itself is not necessarily required; appropriate treatment for the spinal caries should be commenced and the abscess watched, for in many instances as the bone disease becomes quiescent, the abscess will disappear gradually. If, however, in spite of fixation, the abscess is increasing in size, it should at first be aspirated from the side of the neck, and this may be repeated several times until it ceases to refill; if this is not successful, the abscess will need opening and evacuating. Such an abscess should never be opened from inside the pharynx, as this entails both the risk of suffocation and the certainty of pyogenic infection. An incision should be made through sound skin along the posterior border of the sternomastoid, the abscess exposed, opened, evacuated and gently curetted. It is then filled with iodoform emulsion and closed again without drainage.

Dorsal Region. In the cervicodorsal region there are few special features. Pain radiates down the arms or is referred to the sternum, while deformity is usually early and marked, the neck sometimes being stunted as described above. Rigidity is difficult to discover, while abscesses come to the surface in the posterior triangle of the neck; they are sometimes seen in the axilla, the posterior mediastinum or the pleura.

In the mid-dorsal region the disease is common. Stiffness and rigidity are marked, though difficult to demonstrate, the patient refusing to bend the back and reaching down to pick an object off the floor by keeping his back straight and bending his knees and hips. Jolting or jarring is particularly painful, while children are often seen to take up a crouching attitude, bending their back, and resting their hands on their knees or on chairs and tables to take the weight off the spine. Angular deformity is usually very well marked, for several vertebræ will be diseased, and the length of the spinous processes in this situation makes the posterior projection very noticeable; the normal backward convexity in this region also makes an angular deformity more obvious. The spine above and below the diseased segment will then undergo compensatory lordosis in order to keep the head erect, while secondary deformities of the ribs and sternum may follow, giving rise to disturbance of the functions of the heart and lungs. It is in this situation that the typical tuberculous hunchback occurs. Pain is severe, it is referred to the chest and abdomen, while the patient if a child sometimes exhibits a grunting respiration or hacking cough.

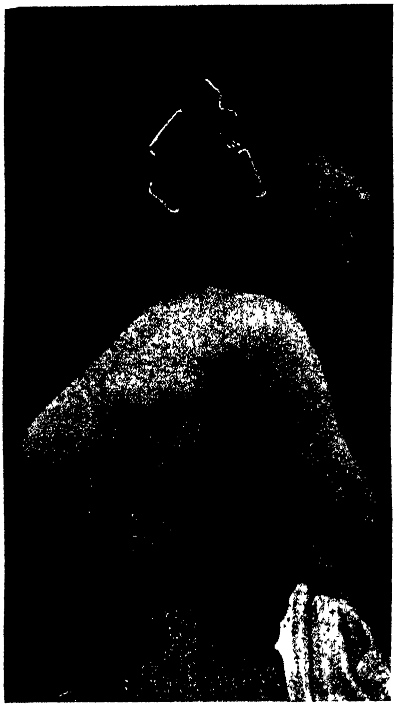

FIG. 38. Tuberculosis of the dorsal spine with severe angular kyphosis.

Paraplegia is especially common in this situation.

Abscess formation is common, and inasmuch as spinal abscesses are painless, they are often not noticed until they reach a large size. The abscess starts in front of the spine and may form a large collection in the mediastinum (**mediastinal abscess**). This sometimes will give rise to pressure upon intrathoracic structures, especially the œsophagus, and it can be diagnosed by its appearances in the X-ray film. More commonly the pus tracks backwards between two ribs following the posterior primary division of a spinal nerve, and comes to the surface three or four inches to one side of the spine, forming a **dorsal abscess,** which appears as a fluctuating subcutaneous swelling, often with an impulse on coughing. In other cases the pus tracks further forwards, running round inside the ribs, and comes to the surface at the spot where the lateral subcutaneous branches of the intercostal nerves branch off. It then gives rise to a subcutaneous abscess over a rib, and will resemble closely tuberculous caries of the rib (see p. 440). It is sometimes actually the cause of tuberculous caries of the rib setting in, as the pus may get under the periosteum and infect the bone. In rare cases the pus gets into the pleura and gives rise to an empyema ; occasionally it is found to present itself lower down in the lumbar region through the triangle of Petit, while when the disease occurs in the lowest dorsal vertebræ the pus may pass under the ligamentum arcuatum internum and give rise to a psoas abscess (*q.v.*).

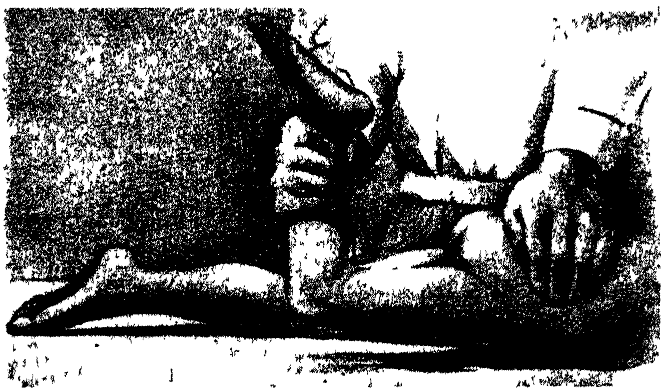

FIG. 39. Method of testing whether full extension of the hip is possible.

Treatment. The treatment of dorsal caries is that of spinal caries in general. In the lower dorsal region postural treatment is to be advocated (see p. 124).

Mediastinal abscesses should be evacuated if they are causing pressure, and this is best done by means of the operation of costotransversectomy. The transverse process on one side of one or more vertebræ is removed together with the head, neck and tuberosity of the rib attached to it. The abscess is then approached in front of the body of the vertebra, evacuated, curetted and sewn up without drainage.

The treatment of dorsal abscesses is that of cold abscess in general (see Vol. I., Ch. VI.).

Lumbar Region. In the upper lumbar region the features of the disease are very similar to those in the dorsal region, with the exception that deformity is not usually so marked, as the bodies of the lumbar vertebræ are particularly rigid and strong. In the early stages, at any rate, the only noticeable deformity will be a flattening of the normal lumbar forward convexity, and this is sometimes preceded by lordosis. Pain, stiffness and rigidity are marked, while the patient will assume characteristic attitudes to keep the weight off the lumbar spine. A considerable amount of spasm of one or both psoas muscles is often present also, this leading to flexion of the hips with internal rotation.

The pain is often referred to the abdomen or inguinal region, and it will be found that children complain of a " stomach-ache," or else of pain in the buttocks and legs, while if any involvement of the nervous system is present, it is quite likely that this will affect the nerve roots of the cauda equina rather than the spinal cord itself. Abscess formation is especially common in this situation, and two forms of abscess will be seen. The commonest is:

(*a*) **Psoas Abscess.** In this case, the pus spreads down from the spine within the sheath of the psoas muscle, and it tracks all down inside this sheath to the iliac fossa, whence it passes under Poupart's ligament into the thigh; while such an abscess is forming it is often found that the psoas muscle passes into spasm and produces fixed flexion of the hip joint. After passing into the thigh, the abscess tracks down behind and outside the main vessels to the neighbourhood of the lesser trochanter and burrows among the adductor muscles. The communication between the iliac fossa and the thigh under Poupart's ligament is often very small, so that the abscess may be of an hour-glass shape. The abscess will thus present itself as a fluctuating swelling, not very tense, sometimes first noticed just above Poupart's ligament in the iliac fossa, but more commonly appearing just below Poupart's ligament to the outer side of the vessels. In addition to distinct fluctuation, there will be an expansile impulse on coughing, and fluctuation can be obtained between that portion of the abscess above and that below Poupart's ligament. In some cases the pus tracks to the inner side of the thigh, coming to the surface and giving rise to a cystic swelling to the inner side of the vessels. As this swelling has an impulse on coughing, it will resemble closely a femoral hernia, for it will become smaller when the patient lies down and may give rise to a false sense of reduction. The fact, however, that it is fluid and that fluctuation can be obtained between the parts above and below Poupart's ligament should prevent this error.

In other instances the pus has tracked backwards and, following the internal circumflex artery, has come to the surface behind the great trochanter, while cases have been described in which it has followed the main vessel down the thigh through Hunter's canal to the popliteal space and presented there. It has been known to track even further and come to the surface for the first time behind the internal malleolus at the ankle. In other instances, the pus fails to pass below Poupart's ligament, but invades the sheath of the iliacus muscle and forms an **iliac abscess** in the iliac fossa; or it may track into the true pelvis and present itself, either in the ischiorectal fossa or deeply in the buttock, by passing out through the sacrosciatic foramen (**subgluteal abscess**). In some cases it has even passed out through the obturator foramen and reached the thigh or perineum in this way.

These abscesses are usually painless until the skin is becoming involved; they give rise to no leucocytosis and little rise of temperature.

Psoas abscess (and psoas spasm) are not always due to lumbar caries; the sheath may be infected from an inflamed appendix lying on the muscle or from breaking down of the deep iliac glands, while disease of the sacroiliac joint will sometimes involve this muscle. Abscesses due to disease of the hip joint are very rarely above Poupart's ligament.

(*b*) **Lumbar Abscess.** Less commonly the pus passes backwards along the posterior branches of the lumbar vessels and nerves toward the outer border of the erector spinæ, in which case it will come to the surface in the back, either two or three inches to the side of the midline or else more laterally still, through the triangle of Petit. It will present itself here as a chronic painless fluctuating swelling, which sometimes will have an impulse on coughing. An abscess forming in the lumbar region is not necessarily always connected with the spine, as a perinephric abscess originating in the kidney or appendix will sometimes present here. It must not be forgotten that in many cases of spinal caries the first thing noticed at all by either the patient or the doctor is the appearance of one or other of these abscesses, while in the case of disease of the lumbar spine the condition will often be difficult to distinguish from tuberculosis of the hip joint or of the sacroiliac joint (see Vol. I., Ch. XIX.).

Treatment. The treatment of lumbar caries is the same as that of spinal caries in general.

Lumbar or psoas abscesses frequently will disappear as the spine becomes quiescent under treatment, and they therefore should be watched at first with this object in view. If, however, they are progressing and appear to be coming near the surface, they should be aspirated by a large trocar and canula and treated, in the way described on p. 124, by absolute rest. Several aspirations probably will be necessary. A psoas abscess is best tapped above Poupart's ligament, as in this situation it will have a better and thicker covering of soft tissues, and the track of the needle is less likely to become infected by tuberculosis.

FIG. 40. Spinal caries with large lumbar abscesses.

If aspiration fails it will be necessary to open the abscess, curette it gently with a flushing curette and endeavour to remove granulations, débris and caseous material. Iodoform emulsion is then injected and the skin incision sewn up without drainage. This method is by no means free from the risk of the wound becoming infected with tuberculosis, a sinus forming, and septic infection becoming superadded. If it is necessary to adopt this treatment, a dorsal abscess is best opened by an incision immediately over it, but in the case of a psoas abscess, though this may be done either below Poupart's ligament or immediately above the ligament, either of these spots is a very long way from the source of the disease in the lumbar spine, while the tissues covering the abscess there are thin and poor. It is undoubtedly better, therefore, in the case of a psoas abscess to make the incision in the back at the outer edge of the erector spinæ and cut down upon and open the psoas sheath in this situation as near to the lumbar spine as possible. Granulation tissue and the abscess contents can then be removed easily, while the actual bodies of the vertebræ may be explored and curetted and carious fragments or sequestra removed.

Lumbosacral Region. Caries in the lower lumbar region and the sacral region is rare and is seen only in adults, while many of the characteristic signs and features are absent. Pain is slight, while, this being a more or less immobile portion of the spine, rigidity and deformity will not be seen. Such pain as occurs is usually referred down the sciatic nerve. A good X-ray film usually will render the diagnosis certain, while in many cases this will depend largely upon the sudden appearance of a cold abscess or symptoms of paralysis of the sacral or lower lumbar nerve roots.

An abscess in connection with caries in this situation either occurs at the back over the sacrum or more commonly in front in the iliac fossa in the form of an **iliac abscess.** This may be uni- or bi-lateral, the pus lying within the sheath of the iliacus muscle and the abscess giving rise to a round, fluctuating, painless swelling, deeply placed in the iliac fossa and sooner or later bulging forwards above the outer part of Poupart's ligament. Iliac abscesses are also not infrequently seen as the result of sacroiliac disease (see Vol. I., Ch. XX.), caries of the lumbar spine and caries of the crest of the ilium. In other instances an abscess from the lumbosacral spine tracks down into the pelvis and ischiorectal fossa, giving rise to a **pelvirectal abscess.**

Tuberculosis of the Sacroiliac Joint. This condition is considered among the diseases of joints in Vol. I., Ch. XIX. It is not infrequently secondary to disease of the lower lumbar vertebræ, the sacrum or the ilium.

OSTEOARTHRITIS OF THE SPINE (ARTHRITIS DEFORMANS, SPONDYLITIS DEFORMANS)

This is a disease of unknown origin which closely resembles osteoarthritis elsewhere in its pathological changes, the spine gradually becoming stiff and fixed and at the same time bending forward, as the result of bony ankylosis occurring between the vertebral bodies. The intervertebral discs become absorbed and disappear, lipping occurs at the top and bottom of the bodies, while ultimately these bodies become fused together by a complete layer of new bone, which runs all down their anterior surfaces and looks like cement that has been laid on by a mason's trowel. The transverse processes may become fused also, while similar changes will be found in the joints between the vertebræ and ribs. A large portion of the spine containing many vertebræ is usually involved. It must be remembered that this is the only portion of the body in which osteoarthritis causes a true bony ankylosis. The spine is sometimes the only region affected, but in other cases the joints (especially the hips) will be osteoarthritic also. In some instances a septic focus will be found elsewhere in the body, which is possibly the cause of the condition, but this is by no means invariable. Several different varieties of this disease have been described by Marie and Strümpel, Von Bechterew, Kümmel, etc.

The disease is more common in males and is usually seen in people over forty who have followed laborious occupations and been much exposed to cold and wet, especially when in the bending position. Thus it is especially found in agricultural labourers and navvies, and in some instances there will be found to be a previous history of rheumatism, gonorrhœa or injury, or of similar disease in other members of the family. The patient at first complains of pain and stiffness in the back, and he gradually becomes bowed forward and shorter than he was, the spine in the course of a year or so becoming fixed, rigid and kyphotic. Pain is often very severe and is then due to pressure upon the nerve roots, where they pass out through the intervertebral foramina, by bony osteophytes. When severe, this nerve pressure may give rise to anæsthesia and paralysis in the roots concerned. In some cases the spinal curvature becomes very pronounced, the patient being bent almost double, and facing the ground, his shoulders rounded, chest flattened and the chin drawn down on the sternum, while tremors and atrophy are sometimes seen in the trunk muscles. In other varieties there is very little bending or deformity of the spine, and the patient's only complaint is of pain radiating along the nerve roots, while the X-ray films will show nothing except lipping of the vertebral bodies. In this latter case, when the disease commences, as it often does, in the lower dorsal and lumbar regions, the pain will closely resemble renal or gastrointestinal pain. There is evidence that in certain cases degenerative changes ultimately supervene in the posterior columns of the cord, while in all cases there is a tendency later on, when the costovertebral articulations become involved, for respiratory embarrassment to ensue and death to occur from pulmonary diseases.

Somewhat similar spinal changes are sometimes seen in osteitis deformans (see Vol. I., Ch. XVIII.), but in the latter case there will be in addition marked changes in the long bones.

Other cases will be seen in which the condition comes on very rapidly and acutely, especially in the cervical spine, pain, stiffness and rigidity being marked and the head sometimes assuming a position of torticollis, while there may be pressure upon the nerve roots. In this variety the cause is probably more of a rheumatic nature, and less in the way of bony changes will be seen in the X-ray picture.

This disease may frequently resemble tuberculous caries or malignant disease of the spine. The diagnosis will rest very largely upon the X-ray appearances of the bones.

Treatment. Very little can be done to relieve these unfortunate patients. The treatment of osteoarthritis in general (see Vol. I., Ch. XIX.) should be applied, while it is important to discover and treat any local focus of infection. The spine must be kept at rest and supported during the early and painful stages.

Coccydynia. This is a condition in which there is severe pain in the coccyx, sometimes confined to this bone and in other instances referred down the sacral and coccygeal nerves. The pain is made worse on sitting, walking or defæcation, and is described by the patient as being excruciating. It is never seen except in neurotic females; there is usually a very definite history of injury to the coccyx, caused either by a kick, fall or blow, or during labour, though there is no evidence as a rule of any fracture of the bone. The coccyx when examined either from outside or from the rectum is very tender, and sometimes appears to be fixed, while its tip is often abnormally turned in. It is possible that the condition is due to adherence of the sacral nerves to the coccygeal periosteum following severe bruising. If sedatives and general treatment fail to give relief, as they usually do, the condition may be relieved by injection of a local anæsthetic in an oily basis (such as A.B.A.) into the coccygeal nerves on either side or by excising the coccyx.

Hysterical Spine. This is a condition met with in young neurotic females, sometimes following an injury (see p. 102), in which the patient complains of severe pain in some portion of the spine, while hyperæsthesia and tenderness over the spinous processes will be present; it is sometimes associated with a natural prominence of one of the spinous processes. General symptoms and other nervous features are usually absent, and in this the condition differs from a railway spine (see p. 102). There is no deformity and no rigidity, although the patient will often make efforts to hold the spine stiff while being examined. The general condition is good, and an X-ray picture will show that the spine is perfectly normal. The treatment is that of hysteria in general.

TUMOURS OF THE SPINE AND SPINAL CORD

Most tumours arising in the vertebræ are malignant, and they may be primary or secondary in nature. Those, however, arising in the spinal cord and meninges are not infrequently simple.

Tumours of the Bones of the Spine. Very occasionally a chondroma, osteoma or hydatid cyst will be seen arising in this situation, but the majority of these growths are either sarcomata, primary or secondary, or else secondary carcinomata or hypernephromata; deposits of lymphadenoma in the vertebræ are not unknown. Primary sarcoma of the spine usually does not ossify as it does in other bones. Secondary carcinoma is common and is particularly seen in association with colloid growths and with carcinoma of the breast, the prostate, the uterus or the thyroid. The deposits are often multiple and found in several different regions of the spine, but nearly always occur in the vertebral bodies. *Whatever the nature of the malignant deposit in the vertebræ, the symptoms are very similar, and will resemble those of Pott's* disease or arthritis deformans. There *is severe continuous localised pain, un*influenced by rest or any *other treatment, at first confined to the spine itself,* but soon radiating along the course of nerves *emerging in the neighbourhood.* Deformity usually sets in rapidly, but is not constant; it is of a rounded nature, and does not consist in sharp angulation. It may become very marked in cases of secondary carcinoma, where the vertebral bodies are extensively softened. The course is rapid, and characteristic changes soon will be seen in the X-ray film. After a comparatively short time the vertebral canal becomes involved and the cord is pressed upon, with the result that a complete paraplegia sets in, and this paraplegia is often of very rapid development, coming on sometimes in a most complete form in a few hours. When due to malignant disease it is always associated with severe pain from pressure upon nerve roots, and is therefore sometimes known as "paraplegia dolorosa." When the disease occurs in the lumbosacral region, the pain is that of a double sciatica, and mistakes in diagnosis often will occur for this reason, while should the deposit occur in the cervical region, paralysis will set in in all four limbs with great suddenness, and death will then occur probably within a few days from respiratory complications. In the majority of cases there is no treatment except to relieve pain, though occasionally an early case of primary malignant disease will be seen in which an exploration and an attempt to remove the growth may seem justifiable.

Chordoma. The *notochord* is the primitive axis round which the mesoblast of the spinal column develops. This should disappear in early fœtal life, though traces of it may be found in infancy in the nucleus pulposus of the intervertebral discs. Persistent rudiments also may be formed rarely at the base of the skull and near the coccyx, the former usually being a button-like protrusion sticking into the skull from its base. A chordoma is a tumour arising in one of these rudiments of the notochord, and usually of low malignancy. It usually occurs in the spheno-occipital or coccygeal regions, grows slowly but gradually infiltrates the tissues round. Very rarely does it mina, by bony osteophytes. When severe, this nerve pressure may give rise to anæsthesia and paralysis in the roots concerned. In some cases the spinal curvature becomes very pronounced, the patient being bent almost double, and facing the ground, his shoulders rounded, chest flattened and the chin drawn down on the sternum, while tremors and atrophy are sometimes seen in the trunk muscles. In other varieties there is very little bending or deformity of the spine, and the patient's only complaint is of pain radiating along the nerve roots, while the X-ray films will show nothing except lipping of the vertebral bodies. In this latter case, when the disease commences, as it often does, in the lower dorsal and lumbar regions, the pain will closely resemble renal or gastrointestinal pain. There is evidence that in certain cases degenerative changes ultimately supervene in the posterior columns of the cord, while in all cases there is a tendency later on, when the costovertebral articulations become involved, for respiratory embarrassment to ensue and death to occur from pulmonary diseases.

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TUMOURS OF THE SPINE AND SPINAL CORD

Most tumours arising in the vertebræ are malignant, and they may be primary or secondary in nature. Those, however, arising in the spinal cord and meninges are not infrequently simple.

Tumours of the Bones of the Spine. Very occasionally a chondroma, osteoma or hydatid cyst will be seen arising in this situation, but the majority of these growths are either sarcomata, primary or secondary, or else secondary carcinomata or hypernephromata ; deposits of lymphadenoma in the vertebræ are not unknown. Primary sarcoma of the spine usually does not ossify as it does in other bones. Secondary carcinoma is common and is particularly seen in association with colloid growths and with carcinoma of the breast, the prostate, the uterus or the thyroid. The deposits are often multiple and found in several different regions of the spine, but nearly always occur in the vertebral bodies. Whatever the nature of the malignant deposit in the vertebræ, the symptoms are very similar, and will resemble those of Pott's disease or arthritis deformans. There is severe continuous localised pain, uninfluenced by rest or any other treatment, at first confined to the spine itself, but soon radiating along the course of nerves emerging in the neighbourhood. Deformity usually sets in rapidly, but is not constant ; it is of a rounded nature, and does not consist in sharp angulation. It may become very marked in cases of secondary carcinoma, where the vertebral bodies are extensively softened. The course is rapid, and characteristic changes soon will be seen in the X-ray film. After a comparatively short time the vertebral canal becomes involved and the cord is pressed upon, with the result that a complete paraplegia sets in, and this paraplegia is often of very rapid development, coming on sometimes in a most complete form in a few hours. When due to malignant disease it is always associated with severe pain from pressure upon nerve roots, and is therefore sometimes known as "paraplegia dolorosa." When the disease occurs in the lumbosacral region, the pain is that of a double sciatica, and mistakes in diagnosis often will occur for this reason, while should the deposit occur in the cervical region, paralysis will set in in all four limbs with great suddenness, and death will then occur probably within a few days from respiratory complications. In the majority of cases there is no treatment except to relieve pain, though occasionally an early case of primary malignant disease will be seen in which an exploration and an attempt to remove the growth may seem justifiable.

Chordoma. The *notochord* is the primitive axis round which the mesoblast of the spinal column develops. This should disappear in early fœtal life, though traces of it may be found in infancy in the nucleus pulposus of the intervertebral discs. Persistent rudiments also may be formed rarely at the base of the skull and near the coccyx, the former usually being a button-like protrusion sticking into the skull from its base. A chordoma is a tumour arising in one of these rudiments of the notochord, and usually of low malignancy. It usually occurs in the spheno-occipital or coccygeal regions, grows slowly but gradually infiltrates the tissues round. Very rarely does it cause metastases. It is usually seen in adults of about thirty or forty: the occipital type expands the nasopharynx, orbit or air sinuses, while the coccygeal type may lie in front of the bone and press on the bowel. The growth is bluish, encapsuled and lobulated with dense fibrous trabeculæ in it. Microscopically, there are masses of epithelial cells arranged in alveoli with large vacuoles in them. Much of the tissue appears gelatinous. Local removal may be possible, and, though likely to be incomplete, will prolong life for a long time.

Tumours of the Spinal Cord and Meninges. These growths may arise in three different situations:—

(*a*) Outside the dura, either from the extradural tissues or from the bones of the spine. This is the least common variety; the growths occurring in this situation are either osteoma, lipoma, neurofibroma, sarcoma or secondary malignant growths.

(*b*) Those growing from the meninges themselves; these are comparatively common, and are usually gumma, primary sarcoma, endothelioma, fibroma, psammoma or hydatids.

(*c*) Those growing in the spinal cord itself, and in this situation the tumours found are usually glioma, sarcoma, gumma or tuberculoma.

They are sometimes divided into two broad classes of intra- and extramedullary tumours. The diagnosis of their nature and origin often will be impossible until operation has been performed. Whatever the origin of spinal tumours, they are found to be more common at the back of the cord, while they are most often seen in the cervical or dorsal region; they occur at all ages.

The symptoms caused by these tumours are usually of slow and insidious onset and depend upon whether the nerve roots or the cord itself are pressed upon and in what order these structures are affected.

(A) Pressure upon the nerve roots gives rise to very severe referred pain, either in the nature of a girdle pain or shooting down the arms and legs. This pain will be uni- or bi-lateral, according to the situation of the tumour, *i.e.*, whether it is near the midline or not. The pain is often preceded for a short time by paræsthesia, *i.e.*, numbness, tingling or formication in the course of the roots involved; while it may be succeeded after some time by anæsthesia of the areas concerned, though such anæsthesia is seldom absolute unless more than one root is involved. Motor roots are seldom involved, but if they are there will be at first painful spasms of the muscles supplied, and after a short time they will become partially paralysed, the paralysis being of the lower motor neurone type.

(B) Pressure upon the cord itself at first causes severe pain referred to the segment pressed upon, but this referred pain, perhaps unilateral at first, soon becomes bilateral, and the areas to which the pain is referred become anæsthetic far sooner than in the cases of pressure upon nerve roots. This pain, due to involvement of the cord, is often at first accompanied by painful muscle spasms, but it is very soon followed by motor weakness and then by complete paraplegia, which is of a spastic type, while those muscles supplied directly from the segment which the tumour involves will be paralysed, flaccid and wasted. In some instances only one half of the cord will be involved, and the phenomena will then be similar to those described by Brown-Séquard, where there will be spastic paralysis and loss of the sensations of muscle sense and touch on the same side as the tumour with loss of pain and temperature sense on the opposite side. In all these cases the usual changes in the rectal and bladder functions will follow soon, while in those cases where the symptoms are primarily unilateral both sides will become involved after a time.

(*a*) In the *extradural* varieties the pain is due to unilateral root involvement, and consists of severe radiating pains on one side. Later, signs of pressure upon the cord will set in, commencing at first on one side and ultimately involving the whole cord. These extradural tumours do not as a rule infiltrate the cord, but only press upon it, with the result that if removed by operation before the cord is seriously damaged or degenerated there is very reasonable chance of the power of the cord being recovered.

(*b*) Those growing from the meninges usually produce symptoms due to pressure upon nerve roots and pressure upon the cord more or less simultaneously, but the pain usually remains unilateral for some time. It will be seen that in these two varieties ((*a*) and (*b*), sometimes described as the extramedullary tumours) the first and most prominent symptoms are referred pains due to pressure upon nerve roots.

(*c*) Those growing in the spinal cord itself (or the intramedullary variety) give rise to very little nerve root pain at the commencement, while such pain as there is is usually bilateral; so the symptoms are chiefly those of a partial paraplegia from the commencement, while there sometimes will be Brown-Séquard phenomena or dissociation of sensations. In addition to the pain being less severe in this variety and seldom beginning at the commencement of the disease, the paraplegia is often less complete than in the extramedullary variety, whilst it also must be remembered that, growing within the substance of the cord as they do and frequently infiltrating it, the intramedullary type are seldom capable of being removed by operation.

The localisation of the level of a spinal tumour is of paramount importance, and depends largely upon the level of the nerve roots involved, the anæsthesia present and the motor symptoms, while it should be remembered that the lesion is often one or two segments higher in the cord than these symptoms would indicate. A more accurate method of localising the level of a spinal tumour by means of the injection into the spinal theca, by lumbar puncture, of a fluid opaque to X-rays is now being extensively used (Vol. I., Ch. XXIII.). This fluid is known as lipiodol, and is made in two varieties, one lighter and the other heavier than the cerebrospinal fluid. The lighter one is injected below the tumour and rises up inside the dura until it reaches the point where the tumour prevents its going further. The heavier fluid is injected above the tumour and sinks down until the tumour stops it. An X-ray photograph is then taken, and by this means an accurate localisation of the upper and lower limits of the growth can be obtained. Certain cases of chronic serous meningitis have been attributed to the use of lipiodol.

An examination of the cerebrospinal fluid is of great importance, as it is found that a yellowish fluid with high albumen and globulin content is diagnostic of a spinal tumour. The occurrence of a yellowish cerebrospinal fluid below the tumour with a clear fluid above it is known as *Froin's syndrome*. The possibility of the disease being syphilitic should always be remembered, while in some instances the condition may resemble closely syringomyelia, chronic spinal meningitis (see p. 139) and myelitis. This latter condition in the form of compression-myelitis is sometimes the result of the prolonged pressure produced on the cord by a spinal tumour, as well as by caries, aneurysms, etc.

A differential estimation of the spinal fluid pressure by Queckenstedt's test is often of value (see p. 8).

Pressure on a lumbar root from herniation of a nucleus pulposus may closely resemble a spinal tumour (see p. 139).

Treatment. As many of these conditions are syphilitic, a preliminary course of antisyphilitic treatment, and especially iodide of potassium, should be tried for two or three weeks before determining upon an operation. As the outlook for a patient with a spinal tumour is bound to be fatal if no relief is given, an exploratory laminectomy always should be performed except in the case of secondary growths. The localisation of the level of the tumour is of the greatest importance (see p. 137). In many cases there is tenderness of the spinous processes over the tumour. In the case of extradural and meningeal growths, the laminectomy is undertaken with a view, if possible, to removing the growth completely, and this often can be done, especially if it is an endothelioma or fibroma, in which case the outlook is very good and a complete cure quite likely. In the case, however, of an intramedullary growth it is not likely that complete removal will be possible, but here a simple laminectomy to produce a decompression of the cord probably will relieve the symptoms and the pain temporarily. In other cases where the tumour is inoperable it may be possible to relieve pain by resecting certain of the posterior nerve roots in its neighbourhood. This clearly will depend upon the situation and nature of the growth.

Myelitis. This is a condition of local degeneration or destruction which may affect certain portions of the spinal cord as a result of hæmorrhage into it, injuries, pressure upon it by bony fragments, tuberculous abscesses, new growths, granulation tissue, callus, or scar tissue. It is also sometimes caused by direct extension into the cord of infection from the meninges. In other *cases which may be regarded as medical, it is the direct result of certain toxins, or possibly of a definite blood-borne infection of the cord, such as syphilis, or in pneumococcal or influenzal cases.*

In these cases a localised portion of the cord becomes red, congested and later flabby and softened, the nerve cells and filaments being destroyed and finally being replaced by fibrous scar tissue, while there is a marked tendency for the change to spread slowly up the cord.

The symptoms are variable, and may be of an acute or chronic nature. There will be pain down the back and down those nerves which arise in the diseased segments, while paraplegic symptoms soon come on. Various sensory changes will be present, and the physical signs will slowly spread up the trunk, while sooner or later the bladder and rectum will be involved. The treatment is chiefly symptomatic and also should be directed against the causative agent.

Acute Spinal Meningitis. This is a leptomeningitis and in some cases occurs as the result of a direct spread from the cerebral membranes. In other cases the spinal meninges may be directly infected as a result of injuries, gunshot wounds or spina bifida, and in these cases the infection is very liable to spread to the cranial cavity. The pathological changes are very similar to those in cranial meningitis (see p. 32), pus tending to collect, especially on the posterior surface of the cord.

Sooner or later in its course the symptoms of cranial meningitis (see p. 32) will be present, but attention will be called to the spinal infection by deep-seated and severe pain in the back, extending down individual nerves or round the body (girdle pain), painful cramps, twitchings, and spasms of the muscles, marked hyperæsthesia, especially of the trunk and the legs, and brisk reflexes. The muscles are rigid, especially those of the neck and back, while the rigidity may spread to the limbs, the spasms which occur sometimes resembling those of tetanus. The onset is rapid, with rigors, and the temperature is high and emaciation rapid, while after a few days signs and symptoms suggesting myelitis (*i.e.*, paraplegia and anæsthesia) usually will set in. When the cranial membranes are involved death is almost inevitable, but when the spine only is affected recovery is possible, while some cases tend to pass into a chronic state (see below).

Treatment. Very little can be done except general treatment and the relief of symptoms as they arise. Sedatives and hypnotics will be required, while the bladder and rectum will need attention, and it is often found best to nurse the patient in the prone position. Repeated lumbar puncture often will give relief. Sulphonamides must be administered.

Chronic Spinal Meningitis (Meningitis Circumscripta). This is usually a pachymeningitis which is very chronic, and is accompanied by a certain amount of sclerosis of the surface of the cord; the membranes become thickened and adherent to the cord in places, with the result that locally there is considerable distension of the meninges with cerebrospinal fluid, the fluid being loculated and under considerable tension, while the cord itself appears shrunken and thickened. The nerve roots may be matted and adherent to the membranes. The condition is usually found in the lower part of the cord in adults, and may give rise to symptoms closely resembling a spinal tumour. In some cases it is the result of a previous acute attack, while in others it is chronic from the first, and in these it is frequently but not invariably associated with syphilis. Many cases follow a preceding injury, while others have been reported as due to lipiodol injections (see p. 137).

Clinical Features. These are those of an ill-defined, local lesion of the cord, and therefore may resemble a spinal tumour. The early symptoms are localised pain and weakness of muscles. This usually commences in one leg and spreads to the other, while there will be shooting pains and hyperæsthesia, which is not, however, very definitely localised to any particular roots. The weakness increases and becomes a definite spastic paralysis with rigid muscles and brisk jerks, and the condition finally passes into a double spastic paraplegia. Patches of anæsthesia will appear, but these are not as a rule complete, while there is little tendency for the disease to interfere with the bladder function or to give rise to the formation of bedsores. The condition is hardly ever seen above the mid-thoracic region and is often preceded by an injury.

Treatment. Antisyphilitic treatment is not as a rule helpful, while little can be done in the way of medical or local treatment. Horsley, who first described this condition, recommended that a laminectomy should be done, the meninges opened and washed out with a 1 in 2,000 solution of perchloride of mercury. In most cases an exploratory laminectomy is clearly indicated, as it is difficult to exclude the possibility of a spinal tumour being present, while if a cystic collection is found evacuation of the fluid gives good results.

Damage to and Hernia of the Nucleus Pulposus. Many cases of sciatic pain are due to changes in an intervertebral disc, usually the result of damage. The intervertebral disc is a layer of fibrocartilage whose circumference is tough and adherent to the bone (the annulus fibrosus) but whose central part is softer and subjected to considerable pressure (nucleus pulposus). A lumbar nerve root comes into close connection with part of the annulus fibrosus on its way out of the spinal canal, though it normally should lie loosely amidst fat and connective tissue.

Prolapse of the Nucleus Pulposus. This may be the result of an injury, often trivial, which ruptures the annulus fibrosus so that the pressure forces out a part of the nucleus which forms a small rounded swelling under the posterior longitudinal ligament. In other cases the annulus fibrosus does not rupture but yields, so that a herniation of the nucleus occurs (*Hernia of the annulus fibrosus*). Either of these conditions may compress a lumbar nerve root, which at operation may be found to be stretched over a small hard white swelling. The injury has often been small and may be forgotten and usually affects the disc between the fourth and fifth lumbar vertebræ, so that it is usually the fifth lumbar root which is involved.

Clinical Features. The condition usually occurs in patients between the ages of twenty and forty-five who may remember an injury, generally occurring while they were stooping, thus producing a compression of the intervertebral disc. Sciatic pain is the chief symptom, the pain going down into the heel and back of the leg. The nerve is tender on pressure and stretching, there is no anæsthesia while wasting and diminution of the knee jerk do not usually occur. There is inability completely to flex the hip and the spine. Naturally the patients (and often their doctors) are often under the impression that they have " lumbago " or " sciatica." In some instances pain in the lumbar region is the first symptom only leading after some weeks to sciatic pain. Occasionally the pain is bilateral and it is markedly variable both in its severity and occurence, the patient at times having no pain for weeks on end. These variations are probably due to alterations in the amount of œdema of the prolapsed nucleus. Slight degrees of lumbar rigidity or scoliosis may be found, but bladder and rectal symptoms are seldom present. Examination of the cerebrospinal fluid generally shows no change either in its pressure or content, while an ordinary X-ray film shows no abnormality. But an injection of lipiodal into the theca followed by an X-ray photograph will usually show the lesion as an indentation or filling defect in the shadow while the affected root sheath does not fill. Three to five cubic centimetres of lipiodol are usually injected.

Treatment. This consists in laminectomy. The theca is opened, the nerve root lifted aside and the posterior longitudinal ligament covering the swelling is incised, when a loose fragment of nucleus pulposus can often be removed. The intervertebral disc should be interfered with as little as possible.

Syringomyelia. This disease which is a cystic degeneration of the central portions of the cervical (or occasionally lumbar) enlargement of the spinal cord, sometimes produces truly surgical lesions in addition to its purely neurological phenomena.

Slight degrees of scoliosis are often present with wasting of the muscles of the arm and especially the hand. Dissociation of sensations is usually present and the legs are spastic.

Charcot's joints are often present in this disease, usually in the arm (shoulder or wrist) and are accompanied in the wrist by a peculiar boggy œdematous swelling of the whole wrist and hand. They are not so painless as the corresponding joints in tabes.

DEFORMITIES OF THE VERTEBRAL COLUMN

Apart from deformities due to disease of the bones, certain displacements occur in the spinal column which are dependent upon muscular and ligamentous changes.

Three common deformities of the column are met with: *scoliosis*, in which the column bends laterally and the vertebræ also become rotated; *kyphosis*, in which the spine arches with its convexity backwards; and *lordosis*, in which it bends with its convexity forwards.

It must be remembered that in the fœtus the spine presents a backward convexity throughout its whole length ; when the erect attitude is assumed later on, this backward convexity gives way to a backward concavity in the cervical and lumbar regions, these concavities being due entirely to muscular and ligamentous action, so that they are capable of easy alteration. It must be remembered, also, that in a perfectly normal spine there is often a considerable amount of irregularity in the spinous processes, and that one or more of them may project unduly, this being a great source of profit to bonesetters and other unqualified practitioners.

SCOLIOSIS

This is the commonest variety and consists of a lateral bending of the spine, accompanied by a rotation of the vertebral bodies, the bodies being rotated always towards the convexity of the curve, so that the spinous processes are directed towards the concavity. The actual curving, therefore, as measured by these latter processes, always appears to be less than the true amount. This twisting of the vertebræ is a mechanical effect due to the interlocking of the articular processes, and it occurs to a certain extent during the normal movements of lateral flexion of the spine. At times there is only one curve, which involves the whole spine, but it is more common to find that one primary and other secondary curves are present, the primary curve being the original deviation, and usually seen in the thoracic region. This primary curve has its convexity usually towards the right, this probably being the result of the greater use and development of the right side of the body. To compensate for this primary curve and to keep the head erect and the pelvis straight, compensatory curves in the opposite direction will form above and below the primary curve. The condition is not uncommonly associated with a mild degree of kyphosis. When the deformity becomes marked and has been present for some time, the vertebræ become misshapen, their bodies becoming wedge-shaped and thicker on the convex side than on the concave side. The intervertebral discs undergo similar changes, while the articular processes, laminæ, transverse and spinous processes become curved and approximated on the concave side, and separated on the other side. The ligaments and muscles become secondarily shortened, the muscles being contracted on the

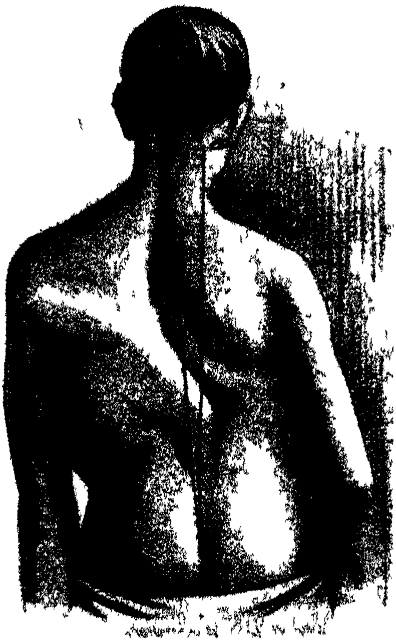


FIG. 41. Marked scoliosis. Line (*a*) is a vertical line up from the centre of the sacrum and line (*b*) is drawn from the first dorsal spine to the centre of the sacrum.

concave side and stretched on the convex side, while occasionally the vertebræ actually become ankylosed together.

Two degrees of lateral spinal curvature therefore must be recognised:—

(*a*) One which can be assumed by a normal spine and does not necessitate any bony deformity or alteration: such a curve is recoverable, and this constitutes far the commonest variety.

(*b*) The more serious type, which the normal spine cannot imitate and which requires an alteration of the structure of the vertebræ for its production—these are not usually remediable.

In the dorsal region the walls of the thorax are affected by the deformity, partly by the bending and still more by the rotation of the vertebral bodies, with the result that the ribs on the convex side become separated and project backwards, a marked hump being formed by their angles a few inches to one side of the spine, so that the front of the chest on this side becomes slightly flattened. On the opposite side the ribs are compressed together, but the curve at their angles is lessened so that the thorax becomes flattened behind, but rather more prominent in front. The shape of the thorax is thus altered. The sternum is pushed over towards the concavity and twisted round so that it looks to one side, the side of the convexity of the spinal curve, while the whole thorax becomes rhomboidal in shape, its capacity when the deformity is marked becoming diminished. The thoracic viscera become displaced and compressed, and even the abdominal viscera may become pushed down or compressed, while the patient appears to have grown shorter and his limbs to have lengthened. Sudden fatal cardiac failure is not uncommon in persons with severe angular deformities of the spine: this is probably due to kinking of the aorta as a result of its clinging to the bent spine. At times an oblique deformity of the pelvis (the scoliotic pelvis) occurs as a secondary deformity. The shoulder on the convex side is raised and the scapula pushed outwards, and this is often the first thing noticed, whilst the waist may be altered, becoming more marked than usual and presenting as a deep sulcus between the ribs and the crest of the ilium The erector spinæ muscles will be found standing out prominently on the convex side, owing

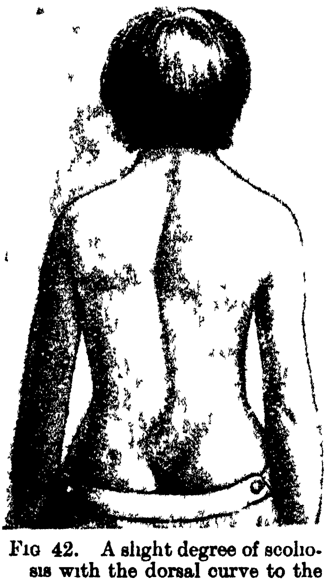


FIG 42. A slight degree of scoliosis with the dorsal curve to the left.

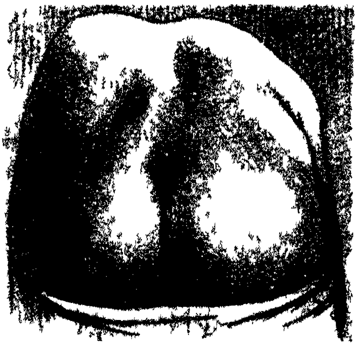


FIG 43 Severe scoliosis with the patient's back flexed, showing the prominence of the ribs.

to the rotation of the vertebral bodies, while on this side the hip will appear unduly prominent.

In severe cases there always will be a certain amount of kyphosis combined with the lateral curve.

In the early stages the deformity will disappear when the patient bends forwards or when the trunk is extended by the patient hanging by his arms, but later on the deformity becomes fixed, and then suspension produces no changes. In very severe cases the patient becomes permanently stunted and dwarfed. However great the deformity is, the spinal cord never becomes compressed.

Causes. (*a*) *Congenital.* This is a rare variety which is seen in small babies. The vertebræ are developed from four centres of ossification, one for each side of the neural arch and one for each side of the body; should there be a lack of ossification of one side of one vertebra, the result is that a wedge-shaped vertebra is produced, which tilts the whole column over to one side. This can be seen in an X-ray film. In this variety the curve is sharper and of a more angular type than in the other forms of scoliosis, and the rotation of the vertebræ is less marked, while the deformity is usually irreducible.

(*b*) *Rickety scoliosis* is seen in young children, where it is the result of the soft and malleable condition of the vertebræ. In this case the primary curve is usually in the lumbar region, and may be the result of the child always having been carried upon the same arm; it may be one of the most severe and intractable forms (see Vol. I., Ch. XVIII.). Similar changes are sometimes seen in older children as a result of adolescent rickets.

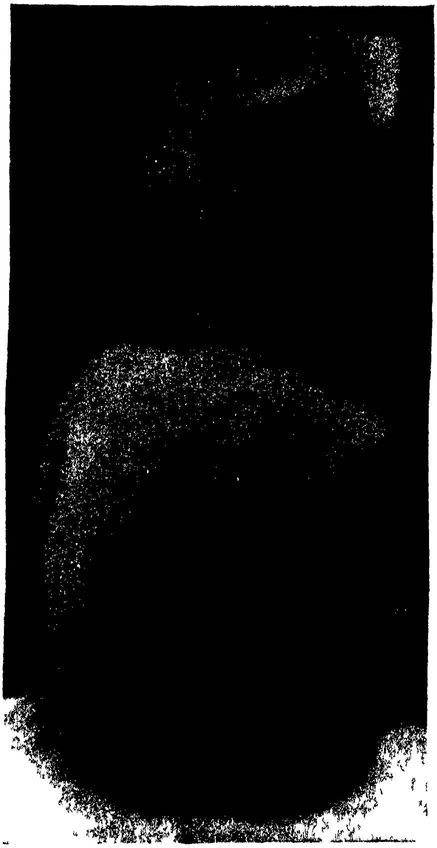


FIG. 44. Congenital scoliosis.

(*c*) An important and common variety is that known as *compensatory scoliosis,* where the condition arises as a secondary deformity, compensatory to tilting of the pelvis as the result of some mechanical asymmetry of the trunk or legs; such as shortness of one leg, pes planus, valgus conditions of the leg or ankle, genu valgum, coxa vara, dislocation of the hip on one side, adduction or abduction of the hip, contraction of the knee, old badly united fractures, deficient epiphyseal growth, genu varum, etc. When, for instance, one leg is shorter than the other, the pelvis drops on that side and this causes the lumbar spine to tilt. The upper portion of the spine then bends in the opposite direction in order to maintain the body and head in the vertical position (see Vol. I., Ch. XX.). When one hip joint is permanently adducted or abducted, tilting of the pelvis again occurs in order to bring the legs parallel to one another (see Vol. I., Ch. XX.), and the result of this is a scoliosis of the same type as the above. In this type of scoliosis it will be noticed that the deformity disappears when the patient sits and is only visible when he is standing, while it can be got rid of by fitting him with a high boot of one or other type in order to compensate for the shortness of the limb, which may be real or apparent (see Vol. I., Ch. XX.).

In other instances scoliosis is due to deformity of the thorax, such as falling in of the chest wall after an empyema operation or in association with phthisis or fibrosis of the lung. Here there is a primary dorsal curve convex towards the normal side of the chest, while the deformity is usually irremediable, but not very pronounced.

In an old-standing torticollis there will be a primary cervical curve, with a compensatory dorsal curve in the opposite direction.

Certain attitudes adopted to relieve pain, such as those seen in sciatica or sacroiliac disease, will give rise to a mild degree of scoliosis of this type owing to the weight of the body being transferred to the normal side. This curve also disappears when the patient sits down.

(*d*) The commonest type of all, which is known as *static scoliosis* (habitual or postural), develops in young people and in adolescents, especially in rapidly growing girls, who are weak and anæmic, possibly as the result of overgrowth, overwork at school or at business, insufficient food and poor hygiene, overlifting, or tight and ill-fitting clothes, while in some cases adenoids, myopia or astigmatism appear to play a part. It undoubtedly often is due to the patient continually taking up faulty attitudes, with the weight carried on only one leg as the result of carelessness or fatigue, and is the result of the skeletal muscles being weak and relaxed, while the ligaments in their turn are also weakened and stretched. The condition is not seen among savage races, while it undoubtedly exhibits a tendency to run in families. It is far more common in girls than in boys, especially amongst school-children, in whom, in addition to the above causes, it may be due also to writing with the right hand and in a faulty position, with the head twisted or the shoulder raised. It is seen also as the result of riding side saddle and in those whose employment necessitates standing on or using one leg more than the other, as in lathe workers, etc.

(*e*) A rare type of the disease is that associated with *unilateral paralysis of the trunk muscles*, or in some cases with unilateral spasm and shortening of these muscles. The former condition is seen chiefly as the result of infantile paralysis and syringomyelia, especially in the muscles round the shoulders, while the latter condition is usually the after-effect of an infantile hemiplegia (Little's disease). Congenital torticollis may also be regarded as another variety of this condition.

(*f*) *Hysterical scoliosis* is occasionally seen in neurotic young women; there is very marked lateral displacement, with very little rotation, while pain is complained of greatly. One or other hip is often firmly adducted also.

Clinical Features. All forms of this disease come on slowly and insidiously, and in some instances the condition is first noticed on account of features which have no direct connection with the spine; thus a dressmaker may notice that one shoulder is growing up and out; or the mother may notice that the hip seems prominent. Some cases present themselves with pain in the breast or ribs, which may be seen to be prominent on account of the scoliosis. In most cases, however, the crookedness of the back is first noticed about the age of puberty, though it is difficult to say how long it has existed. The patient usually has very few symptoms, complaining possibly of feeling tired and weak and occasionally of pain in the back and shoulders, while she may be inclined to lie about and resent standing and walking; if pain is a severe feature it is very probable that caries is present. In very severe cases there will be shortness of breath and interference with the action of the heart, giving rise to palpitation and cardiac pain. The majority of cases seen in hospital practice nowadays are sent up by medical school inspectors who have noticed slight spinal deviations in the routine examination of children. The patient must be examined completely stripped and both in a sitting and a standing position. In early cases the spinal deformity may be very slight and an alteration in the level of the scapular angles may be the only thing detectable. The spinal processes should be marked out with a blue pencil and backward projection of the ribs on one side looked for. This is rendered more noticeable if the arms are folded and the patient bends forward. The patient also may be examined when hanging by the hands from a bar, and then many of the deformities should disappear. A careful examination should be made for a primary cause for the scoliosis, such as shortening or deformity of one of the legs, contraction of the chest, etc. Pott's disease can be excluded always by the absence of rigidity, of angular backward deformity and of localised pain. In many early cases it will be found that the patient can herself correct the deformity and that it will disappear if she stretches her hands above her head as far as possible, or if she stoops forward and touches the floor with her hands.

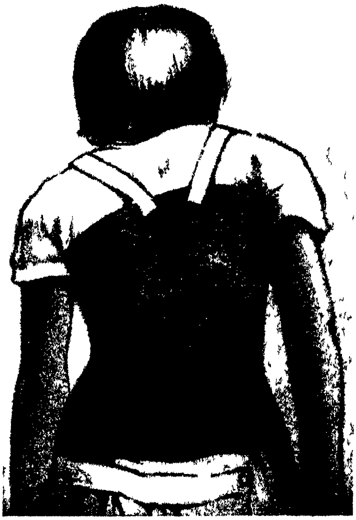
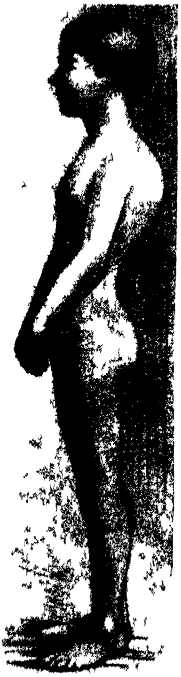


FIG. 45. A spinal jacket fitted to the patient in Fig. 42, showing the reversal of the curve.

Treatment. If the deformity is not fixed and disappears when the patient hangs by the arms, it always can be completely cured. If fixed by ligamentous shortening, muscle contraction or bony changes, it always can be improved, but will never disappear completely. The treatment of the condition is directed first of all at the primary cause. Thus inequality in the length of the legs and deformity of the limbs must be corrected, whilst in the static variety the general health must be improved by tonics, fresh air and proper diet. Errors of posture must be put right and care taken that the patient stands and sits in proper attitudes and at proper desks and chairs. Adenoids may need treatment, and care must be taken in girls to avoid tight and ill-fitting corsets. In some cases myopia or astigmatism will be the cause of the disease, and this should be treated with suitable glasses. Standing still is to be avoided, as the tendency is to stand on one leg, but walking, riding (astride in the case of girls) and other exercises which develop both sides of the body may be indulged in in moderation. There must be a carefully arranged combination of rest and exercise, so that the muscles of the back may be developed and exercised without being unduly tired. Certain special exercises are usually beneficial; deep breathing exercises to increase the capacity of the thorax are also valuable.

In mild cases, where the deformity disappears on suspension, after a short period of complete rest in bed to get rid of the feeling of pain and tiredness, massage, gymnastic exercises and the prophylactic measures mentioned above will usually be sufficient, while rest on a flat board in the supine position for an hour or two daily is useful.

In the more severe cases, when the deformity is not affected by suspension, it is probably permanent, but much can be done to conceal it and prevent it increasing. The treatment here also takes the form of increasing muscular development and special exercises. In very severe cases a supporting spinal jacket may be worn, though this is the last resource, as it will weaken the spinal muscles. Attempts have been made at forcible correction of these fixed deformities by means of successive plaster of Paris jackets applied firmly and tightly with the child completely suspended, and renewed as the correction gradually occurs at intervals of two or three months. By this method correction is not very forcible, and unfortunately the great principle of producing overcorrection cannot be adopted. Other methods are the employment of straps and slings, or of plaster of Paris jackets rather on the lines of those employed in Pott's disease, with windows in them (see p. 124), but these have not been followed by very great success.



Kyphosis and lordosis.

Paralytic scoliosis and that due to disease of the chest require a firmly fitted support as a permanency.

KYPHOSIS

This is a condition in which the dorsal convexity of the back is increased. It is sometimes accompanied by a compensatory lordosis of the lumbar spine, but compensatory curves above the kyphosis are not often seen. It is met with at any age and is due to many causes, while it varies in degree greatly from a sharp acute angle, as seen in Pott's disease, to what may be described as a small degree of round shoulder. Its causes are as follows:—

(1) It may be the result of general or local diseases affecting the bones of the spine. These are osteitis deformans, acromegaly, spondylitis deformans, osteomalacia, hypertrophic osteoarthropathy, or senile atrophy, and in these conditions the kyphosis is general, affecting the whole length of the spine, and no compensatory curves are present. In other diseases the kyphosis is local, and this is seen in Pott's disease, fracture-dislocations, malignant growths of the spine and traumatic spondylitis. In these conditions compensatory curves (lordosis) are usually present in order to keep the head and trunk erect.

(2) Paralytic kyphosis is seen as the result of weakness or paralysis of the spinal muscles in tabes, progressive muscular atrophy, poliomyelitis,

Friedreich's disease, etc. In these cases the kyphosis is often very severe and may involve the whole length of the spine.

(3) Static kyphosis, which is the result of faulty posture or habits. This is a common form, and though in young children it is occasionally due to rickets and general debility, it is more commonly found in adolescents, where it usually occurs in the cervico-dorsal region, and is then due to habits of continuous stooping when reading or writing, to myopia and faulty postures. In more elderly patients it is seen as the result of occupations which involve stooping and carrying heavy weights; thus it is seen in gardeners, agricultural labourers, porters and cobblers, and in these cases no compensatory curves are usually present, as the patient is able to keep his head erect without them. In kyphosis the head is poked forward with a peering attitude, the chest is flattened and the scapulæ are prominent and tilted obliquely.

In the form of "round shoulders" the condition is seen frequently in adolescents, especially in overgrown girls, and in these it is predisposed to by anæmia, myopia, adenoids and stooping postures, especially in reading and writing. The deformity in these cases is usually slight and at first, at any rate, can be corrected voluntarily.

Treatment. The treatment is similar to that of scoliosis and is to a large degree preventive. Faulty attitudes in standing, sitting, reading and writing must be corrected and such conditions as adenoids and myopia attended to. The child must be made to rest on her back for an hour or two every day without a pillow and the spinal muscles should be strengthened by massage, electrical treatment and exercises, while the general health of the patient should be attended to.

LORDOSIS

This is the reverse of the preceding deformity and consists of a curvature of the spine with the convexity forwards. It is almost confined to the lumbar region, where it is usually a secondary or compensatory condition, and this compensatory curve is usually produced by the backward tilting of the pelvis, which occurs when there is some degree of fixed flexion in one or both hip joints. The continued and fixed flexion of the hip may be due to tuberculous disease, either active or after ankylosis has occurred, Charcot's disease, bilateral congenital dislocation or other unreduced dislocations, malunited fractures, etc., and the compensatory lordosis which ensues enables the trunk to remain in the erect position. When the patient sits on a flat surface the tilting of the pelvis disappears and the lordosis vanishes, while if the patient lies on his back on a flat couch the lordosis can be felt by passing the hand in behind the lumbar spine, which will be found to be some distance away from the couch. When this is so the lordosis can be corrected and its amount estimated by lifting the leg on the side on which the hip is flexed off the couch until the flexion produced is equivalent to the fixed flexion in the hip. When this has occurred the pelvis will resume its correct position, the lordosis will disappear and the lumbar spine come into contact with the couch again. Another method of doing this is to lift the sound leg off the couch and flex the hip up until the pelvis is forced back, the lordosis disappears, and the lumbar spine touches the couch. When this occurs, the thigh on the other side on which the hip is flexed and fixed will also rise off the couch. Lordosis is seen occasionally in other regions of the spine as a curve compensatory to a kyphosis above or below it. A double lordosis is sometimes seen above and below a marked kyphotic curve, as a secondary phenomenon.

There is another group of cases in which lordosis occurs, and these are patients who carry heavy weights suspended in front of them; thus it is seen in street hawkers, pregnant women, or patients with large uterine fibroids, ovarian cysts or other large abdominal tumours, and in very stout people with fat and pendulous abdomens. It sometimes occurs in a slight degree as a congenital deformity, and then tends to run in families.

It will be found occasionally in such diseases of the neuromuscular apparatus as affect the muscles which maintain the erect posture. Thus it is seen in progressive muscular atrophy, pseudo-hypertrophic muscular paralysis, etc.

The *treatment* of the condition is entirely that of the conditions to which it is secondary. When these are corrected it will disappear; if these cannot be corrected nothing can or need be done for the lordosis.

Spondylolisthesis. This is a rare condition in which the fifth lumbar vertebra, carrying the vertebral column with it, slips forwards over the top of the sacrum. As a racial feature it occurs especially in American negroes and the Bantu races, when it may be accompanied by a cleft in the laminæ. It is due either to an imperfect development or a fracture of the articular processes of the lumbosacral articulation or of the pedicles of the fifth lumbar vertebra; occasionally it is due to caries of the fifth lumbar vertebra. Two main forms are seen—(1) when there is a congenital separation of the fifth lumbar vertebra into two portions, so that its body is displaced forwards and its spine and lamina with the sacrum, backward; (2) in the less common form, the whole lumbar vertebra steps forwards upon the sacrum and carries the spinal column with it. It occurs equally in either sex. The deformity then takes place and is increased by the action of the weight of the body or of weights carried on the shoulders. Pregnancy naturally will tend to increase it. The patient appears to have an intense lordosis with a marked hollow immediately above the sacrum, his height appears shortened, and the lumbar vertebræ may be felt in front through the abdomen very easily. The condition is accompanied by a considerable amount of pain and disability.

Treatment. The treatment consists first of all of prolonged rest flat on the back for some weeks. This is followed, when the patient gets up, by the application of a moulded leather jacket, while he must use crutches for many months in order to take the weight of his body off the lower part of his spine. Many and heroic orthopædic operations have been devised to reduce the deformity and fix it with bone grafts, but the results are poor, and the wise surgeon will not encourage them.

LAMINECTOMY

This is the operation required in order to expose the spinal cord. Its indications have been mentioned already; it will be required most commonly for the removal of spinal tumours or for the relief of chronic, localised spinal meningitis or to perform resection of the posterior nerve roots. In spinal injuries it is practically never wise to perform a laminectomy if there appears to be a total lesion of the spinal cord, though the operation often will be beneficial in partial lesions or partial compressions of the cord. Occasionally in tuberculous spinal caries when paraplegia is present a laminectomy may be required, and here care must be taken not to open the dura. Foreign bodies in the spinal canal may be removed in this way.

The localisation of spinal lesions has already been referred to on p. 137. The following anatomical points are, however, valuable in connection with the operation. The spinal cord ends at the lower border of the first lumbar vertebra; the dura ends at the upper border of the third sacral vertebra; the lumbar enlargement lies opposite the tenth, eleventh and twelfth dorsal vertebræ; the line joining the highest points of the iliac crest crosses the spine of the fourth lumbar vertebra; the level of the posterior superior iliac spine corresponds to the second sacral vertebra. The root of the scapular spine corresponds to the third dorsal, the angle of the scapula to the seventh dorsal, the epiglottis to the fourth cervical, and the cricoid cartilage to the sixth cervical vertebræ respectively.

It must be remembered that the spinal segments in no respect correspond in level to the vertebræ with similar numbers, the segments always being higher than the corresponding vertebræ. In order to discover what segment is opposite to any particular vertebral spine, in the cervical region add one to the number of the spine; in the upper dorsal region add two; in the lower dorsal region add three; while the third, fourth and fifth lumbar segments all lie opposite the eleventh dorsal spine and the space immediately below it, and the sacral segments lie opposite the twelfth dorsal spine and the space below that.

In performing the operation of laminectomy an intratracheal anæsthetic, though not essential, is of great help. The patient may be placed either prone upon his face or lying on one side, and propped up with pillows into a semi-prone position. An incision is made corresponding in length to at least six vertebral spines; this should not be strictly in the midline, but should take the form of a slightly curved flap extending about one inch to either one or other side of the midline. The large mass of spinal muscles have then to be separated from the spinous processes and laminæ on both sides, and this is best done with a knife and rougine. This step is difficult to perform, and much blood will be lost while it is being done unless care is taken to stop it. This is best done by packing the wound firmly with pads soaked in very hot saline and frequently renewed. Many surgeons then make a practice of cutting away four or five spinous processes with strong forceps at the site required. This is, however, not necessary. The laminæ are then removed by cutting them with a saw, or better, with laminectomy forceps on both sides; they should be cut close to the articular processes and those belonging to at least four or five vertebræ should be removed, care being taken not to damage the dura or the cord. The dura can then be examined, and if it is required to expose the cord, first of all the dura, and finally, the arachnoid mater may be incised and held aside with forceps; the cord and the nerve roots can then be examined. At the end of the operation the dura may be sewn up with a continuous stitch, the muscles brought together with catgut, and the skin neatly closed. The patient should be nursed on his side, and care must be taken in moving him in bed. He may have to wear a spinal support for at least a year after the operation, but most cases are perfectly comfortable and safe without this, as the strength of the spinal column as a whole is not interfered with.

CHAPTER IV

AFFECTIONS OF THE LIPS, FACE, MOUTH AND JAWS

Surgical Anatomy. In connection with the face and lips it must be noticed that the soft tissues here are particularly lax, mobile and well supplied with blood. It follows that wounds and incisions on the face and lips heal both well and quickly without much scarring, and that the facial tissues are particularly favourable for plastic operations and flap cutting, while œdema of the soft tissues and hæmorrhage into them, should it occur, can both spread easily and become very extensive. Œdema especially gives rise to great swelling and disfigurement in the lax tissues of the lips and eyelids. The blood supply and nerve supply of the face is derived from many sources, the former coming from the facial arteries and from branches both of the superficial temporal and internal maxillary vessels; while the nerve supply is derived almost entirely from the fifth cranial nerve. The veins for the most part drain down into the neck to enter the jugular veins, but at the internal angle of the orbit there is free communication via the angular vein with the venous channels inside the skull, especially the cavernous sinus. There is thus always a considerable tendency for septic lesions upon the face and lips to spread within the skull via this path and give rise to grave intracranial infections. The lax subcutaneous tissues of the face are also in direct continuation with the cervical fascia, with the result that septic conditions in the face and jaws frequently will spread down into the neck and thence even into the mediastinum.

Development of the Face and Palate. Congenital malformations of the face and palate are common and their origin and formation depend upon the way in which these structures develop. During early fœtal life the primitive gut ends blindly in front as well as behind; in the first month a depression, known as the stomodæum, forms at the front end of the ventral surface and grows in to meet the primitive gut. The bony and fleshy parts of the palate are developed from a series of processes growing out from the anterior end of the ventral surface of the embryo. Towards the end of the first month of intrauterine life the primitive cerebral vesicle becomes acutely flexed over the end of the notochord, and from the base of the prosencephalon those processes grow out which ultimately form the face: they are five in number and converge to meet each other and to surround the primitive buccal and nasal cavities, this stomodæum appearing, as described above, at first as a stellate depression. Those processes, which are shown diagrammatically in Fig 47A, consist of one median projection which grows down from above and is known as the *frontonasal process*, and on each side of two lateral projections, which grow in from the sides, and the upper of which is called the *maxillary process*, the lower the *mandibular process*. The median frontonasal process consists of two lateral symmetrical halves, and each half of it soon becomes divided by a cleft known as the nasal cleft into two separate processes, an outer one known as the *lateral nasal process*, and an inner one which becomes rounded and is known as the *globular process*. These processes, as well as forming the superficial parts of the face, also tend to send prolongations backwards in the form of shelves which later on unite to form some of the deeper structures, such as the palate. These five processes above described proceed to unite as follows:—the prominent mandibular processes soon unite in the middle line to form the mandibular arch containing Meckel's cartilage, which ultimately becomes the lower jaw and the lower lip, while the shelf-like projection which grows backwards from it forms the floor of the mouth.

The two globular processes unite and their superficial parts form the central portion of the upper lip (the philtrum), while their deeper parts, which project back like a shelf, form the nasal septum and the central portions of the premaxillary bone, the two central incisor teeth developing in this central premaxillary portion. The lateral nasal processes on each side remain separated from the globular processes by the nasal cleft, which ultimately forms the anterior nares, and these lateral nasal processes form the roof of the nasal cavity and the alæ nasi with a small portion of the side of

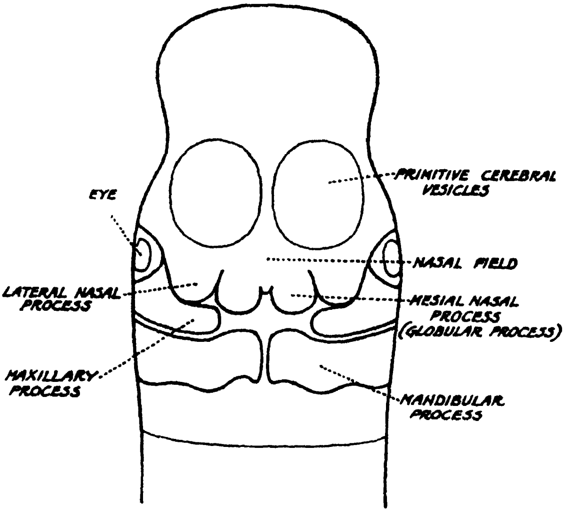


FIG. 47A. Early development of the face.

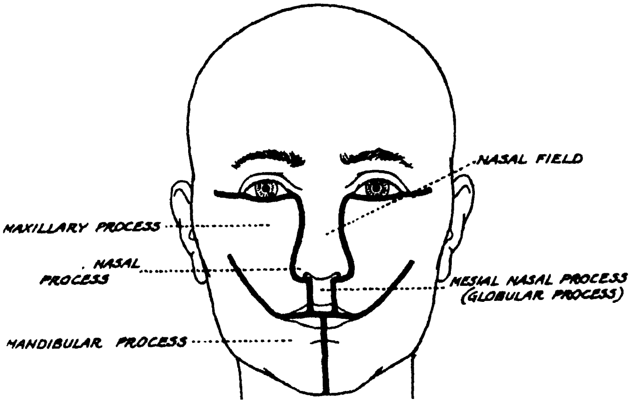


FIG. 47B. Diagram of the processes entering into the formation of the face.

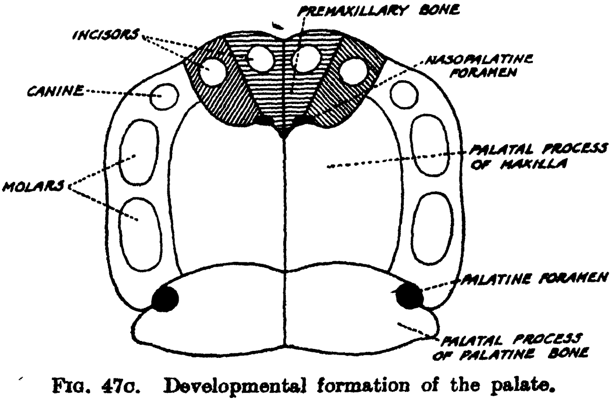


FIG. 47C. Developmental formation of the palate.

the cheek, while the shelf-like backward projection from this process forms the lateral portion of the premaxillary bone in which the two lateral incisor teeth develop. There now exists a cleft between the lateral nasal process and the maxillary process known as the naso-orbital cleft, but this cleft is closed ultimately almost completely by the globular and lateral nasal processes fusing with the maxillary processes, only the deeper portion of the cleft persisting as the nasal duct; thus from the maxillary process are developed the lateral portions of the upper lip, the greater part of the cheeks with some of the facial bones, while the backward projecting shelves from the maxillary processes should meet each other in the middle line to form the whole of the soft palate and all the hard palate except the premaxillary bone. It will be seen, therefore, that the lateral nasal process does not take any part in the formation of the free border of the upper lip, while there are certain clefts and lines of fusion both in the face and the palate as shown in Fig. 47B and 47C which *may be the seat of certain well-defined congenital abnormalities in the future.* The fusion of the projecting plates which form the palate occurs from before backwards, while the development of the face and palate and the fusion of the various processes are usually complete at the end of the tenth week of intrauterine life. The fusion of the two globular processes occurs at a very early stage, almost before any of the other changes have commenced.

Failure of fusion between any of these processes may occur and thus give rise to developmental deformities; the cause of these arrests in development is not known for certain; often they are combined with deformities in other parts of the body such as talipes, imperforate anus or spina bifida; sometimes they appear to run in families, while in other instances syphilis or malnutrition has been thought to account for them.

DEFORMITIES OF THE LIPS AND FACE

Hare Lip. By a hare lip is meant a congenital cleft or notch in the upper lip, and the distance to which this extends either upwards or backwards is very variable. In many instances the condition is associated with a cleft palate, though it is quite common for each of these conditions to exist without the other. The cleft in the human lip in no way resembles the cleft upper lip of a hare. It will be found occasionally that a cleft lip is accompanied by a notch in the alveolus without there being a cleft palate in addition.

Nearly all hare lips are lateral, and though a median hare lip is occasionally seen it is exceedingly rare.

Lateral Hare Lip. This is due to failure of fusion between the globular and maxillary processes on one or both sides.

A hare lip which extends into the nostril is said to be *complete,* otherwise it is *incomplete ;* it is *alveolar* if the alveolus is notched; *simple* if only the soft parts are involved; while it may be either *bilateral,* in which case it is usually alveolar and accompanied by a cleft palate, or it may be *unilateral,* in which case it is more common on the left side and in boys. In the alveolar cases there will be a partial cleft between the premaxillary bone and the remainder of the hard palate, while in the bilateral cases, although the two clefts may be unequal, they are usually both complete, so that the philtrum of the upper lip is completely separated from the rest of the lip. When this is so, and especially if, as is usually the case, there is a complete cleft palate also, the central portion of the lip, together with the separated premaxillary bone, is usually tilted forwards out of line with the rest of the upper jaw, while in severe cases the whole of the premaxillary bone appears to have moved forwards and will be found to be attached often by a thin pedicle near the tip of the nose, giving the child an extraordinary appearance which looks as though it had a proboscis.

Even in quite mild incomplete cases, and still more if the condition is complete, there will be a certain amount of deformity of the nose, which is flattened and has its nostril altered on the side of the cleft. Other deformities, such as talipes and spina bifida, are present sometimes, while the condition exhibits a tendency to run in families; occasionally a lip has no cleft, but a thin red scar-like line will be seen in it.

It will be seen from Figs. 47 A and B, that a lateral hare lip of this kind is due to imperfect fusion between the globular process and the labial portion of the maxillary process, while the cleft in the alveolus, if present, passes between the premaxillary and maxillary bones; but the relation of this cleft to the incisor teeth varies, as the portion of bone in which these teeth develop is not very constant; thus the lateral incisors, though usually on the inner side of the cleft, are occasionally found on the outer side. Though the premaxillary bone consists of two separate portions the cleft usually passes outside it.

Median Hare Lip. This is exceedingly rare. Mild cases are seen occasionally where there is a small central cleft, the result of failure of union of the two globular processes, while occasionally the condition is due to complete absence of the globular processes and the parts developed from them; so that the philtrum, the central part of the premaxillary bone and the nasal septum are missing.

All forms of hare lip, and especially severe forms and bilateral forms, and, above all, those associated with cleft palate, may interfere with the child's power of suckling, so that its nutrition will suffer and treatment become a matter of urgency. The cleft is surrounded by a certain amount of scar tissue, while the fact that the orbicularis oris is defective renders the deformity more noticeable when the child cries or laughs.

Later in life, apart from the deformity, a hare lip is objectionable, as it gives rise to a lisping speech, but much less deficient articulation than that which accompanies a cleft palate.

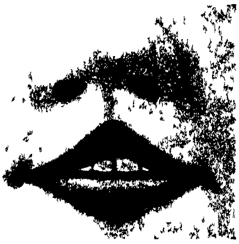


FIG. 48. Median hare lip.

Treatment. Should there be difficulty in suckling, this sometimes may be got over by means of a nipple shield with a flap, but if the condition is severe and a cleft palate is present, the infant will have to be fed by a spoon, the head being held back and the food put right into the pharynx.

The only treatment for the hare lip itself is operation; in the case of a combined hare lip and cleft palate the hare lip should be operated upon first, as this will improve the child's nutrition and the closure of the lip sometimes will cause the cleft in the palate to diminish in size. The earlier the operation on the hare lip is performed the better, though the child should be allowed a week or two to get accustomed to the world which it has entered and to gain a little strength. The operation, therefore, is best performed somewhere between the ages of one and three months, the actual date depending upon the nutrition and circumstances of each particular child; certainly it should be performed before dentition commences.

Operations for Single Hare Lip. Innumerable operations have been devised for this condition, though in principle they are all much the same and consist first in dissecting the lip free from the maxilla and alveolus and cutting through the mucous membrane attaching it. The ala nasi should be mobilised also, especially if the nose is deformed. The edges of the cleft are then pared, and certain flaps cut in such a way that the cleft can be united with the red margin continuous and with a minimum of scarring, while it must be remembered that in the process of healing contraction will occur and that the deformity must be over-corrected, therefore, at first. The various methods of paring the margins and cutting the flaps are described in connection with Figs. 49 and 50 and are known by the names of Rose, Nelaton, Edmund Owen, Mirault, Veau, etc.

When the flaps have been cut and adjusted the gap in the lip is sutured into position without tension, the greatest care being taken to approximate the borders of the red margin. Mucous membrane, muscle and skin must be carefully stitched to the similar tissues on the other side of the gap. Strong sutures of fine catgut and salmon gut are used, silver wire, etc., being quite unnecessary, while the nostril on the affected side should be made rather smaller than that on the normal side, as it is certain to dilate later, the stitches being adjusted to produce a slight prominence at the end of the incision, which will contract subsequently (see Fig. 50). The greatest care must be taken to control hæmorrhage, which often leads to infection and which small children tolerate badly. The wound is dressed with strips of gauze stuck on to it with Whitehead's varnish while tension is best prevented by a special steel clip apparatus in which case *no* dressing is necessary but care must be taken that nasal mucus does not run into and infect the wound, the stitches all being removed by the eighth day and the dressing continued for another four weeks. The child probably will pull at the dressing and try to pick it off, and, therefore, should have short straight splints on his arms so that he cannot bend his elbows. He will have to be fed with a spoon at first, and the mother's milk can be drawn off and given this way. At the end of a week usually, even before the stitches are out, he may be put back on the breast.

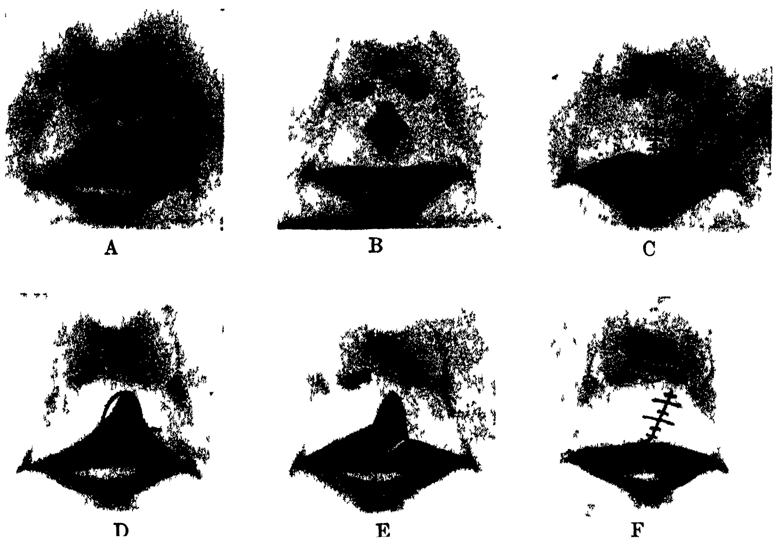


FIG. 49 A, B and C The three stages of Nelaton's operation for hare lip D, E and F are corresponding steps in Mirault's operation

Operations for Double Hare Lip. In this case we have the complication that the premaxillary bone is probably markedly displaced forwards, while, in addition, two clefts have to be dealt with. If the premaxillary bone is not displaced it need not be touched, but when it projects forwards it must be as far as possible replaced in its proper position. The first part of the operation, therefore, will consist in doing this, and in many cases it will be wise to be content to do this only at the first sitting and to close the clefts a few days later. Under no circumstances should the premaxillary bone be removed, as it nearly always can be replaced, and if it is removed the front of the lip and nose will drop in. The bone is best replaced, either by fracturing it back and fixing it into position by silver wire or, better, by resecting the nasal septum and incising a V-shaped wedge of it, in which case it is often possible to slide the bone back into position without rotating it, and in this way the position of the incisor teeth when they erupt will be more natural. The operations which deal with the closure of the double cleft are similar to those already described for single hare lip and are illustrated by means of Fig. 50, A, while the dressing and after-treatment are the same as in the case of the single operation. It will be found sometimes that for a few hours after the operation the child has a difficulty in breathing, as the hole through which it breathes is so much smaller than it was, but this is usually set right by holding the lower lip down for a short time.

In severe cases a condition of microstoma may be produced by this operation; if so, a small plastic operation later will correct this.

Facial Cleft. This is a rare deformity and is due to failure of closure of the naso-orbital fissure in whole or in part. It consists, therefore, of a cleft which will be found in the line of this fissure, starting below in the situation of a hare lip and running up round the side of the nostril towards the inner side of the lower eyelid along the line of the nasal duct. It may involve the soft parts only, but sometimes involves the bones and is occasionally accompanied by a coloboma of the iris. A simple plastic operation will cure this condition.

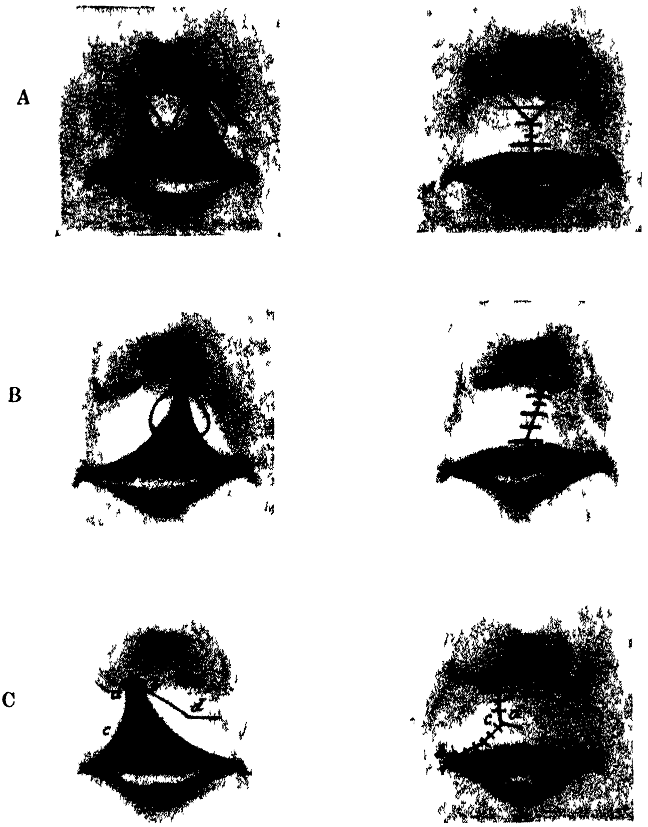


FIG. 50. A. Rose's operation for double hare lip. B. Rose's operation for single hare lip C. Edmund Owen's operation for a single complete hare lip.

Macrostoma and **Microstoma** are due to incomplete fusion and excessive fusion, respectively, between the maxillary and mandibular processes. In the former case the mouth is exceedingly wide, and other developmental defects, such as accessory auricles, often will be present. The limits of the true mouth are often indicated by two small papillæ on each lip which mark the spot where the orbicularis oris is inserted. In microstoma the mouth may be very small, and in some instances only just will admit a probe; occasionally the lower jaw is deformed also. This condition, as well as being sometimes congenital, is often the result of operations upon the lips and cheeks, or previous severe ulceration and scarring.

Mandibular Cleft. This occurs in the middle of the lower lip and sometimes extends a short distance down into the neck. It is due to failure of union of the two mandibular processes and is very rare. Such a cleft usually involves only the soft tissues, but may extend down to the bone.

Fistula of the Lip. Two small openings in the mucous membrane are occasionally found, one on each side of the middle line of the free border of the lower lip; they lead down for about half an inch into a narrow sac under the mucous membrane. Watery fluid comes out of these openings, which are often associated with hare lip and show a considerable familial tendency.

Treatment. All these conditions are easily remedied by small plastic operations, the details of which will depend upon the site and nature of the lesion.

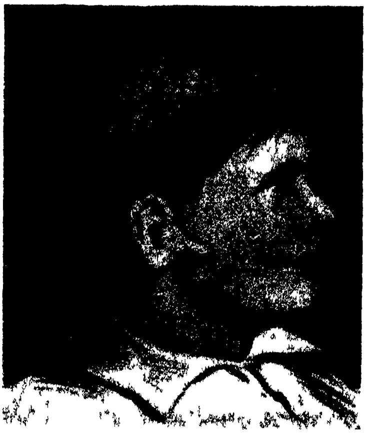


FIG. 51. Macrostoma with an accessory auricle.

INJURIES OF THE LIPS AND FACE

Like the scalp, the blood supply of the lips and face is so free that the vitality of the skin is very great and healing of flaps and damaged portions occurs with the most remarkable completeness and rapidity, while infection is rarely severe; it is even worth while replacing completely separated portions of tissue. These tissues lend themselves very freely for this reason, and also on account of their laxness, to the performance of plastic operations for the correction of deformities which may be due to actual loss of tissue from wounds or cicatricial contraction after burns, lupus and other conditions. *Contraction* of the soft tissues of the face leads to great deformity, as the eyelids may be drawn down and everted, the mouth and nose deformed, or the skin of the neck involved, so that the chin and head are drawn down towards the chest.

Wounds of the face bleed freely, whilst should any of the more important vessels be divided it will be seen that they will bleed from both ends, as the anastomosis is free; in the case of deep or punctured wounds it will be found often that the skull, antrum of Highmore, orbit, mouth or nose are penetrated. In the case of lacerated wounds every effort should be made to clean up the parts, to remove foreign particles, such as grit or dirt ground in, and render the tissues aseptic. The wounds may then be stitched in perfect confidence that they will heal by first intention, while the mucous membrane of the mouth, eyelid, or cheeks should be sutured separately with catgut stitches. If small portions of the nasal, malar, or other bones appear to be detached, they should be removed. Whitehead's varnish is a convenient method of dressing such wounds.

It occasionally happens in wounds of the face that the parotid gland or its duct is involved and saliva will then escape from the wound. If the gland is injured this usually ceases spontaneously, but if the duct is injured a salivary fistula is likely to form (see p. 212). The facial nerve, the supraorbital, the infraorbital, or inferior dental nerves are likely to be damaged, leading respectively to facial paralysis or to loss of sensation.

DISEASES OF THE FACE AND LIPS

The face and lips are subject to the same infections and tumour formations as are the skin and subcutaneous tissues in other parts of the body. Erysipelas, boils, carbuncles and anthrax are seen here frequently, the latter being found particularly over the chin and shaving area from infected shaving brushes. Septic conditions such as these when on the face or upper lip must be regarded as serious lesions on account of their liability to give rise to intracranial infection and general septicæmia, while erysipelas is liable to give rise to œdema of the glottis and stridor.

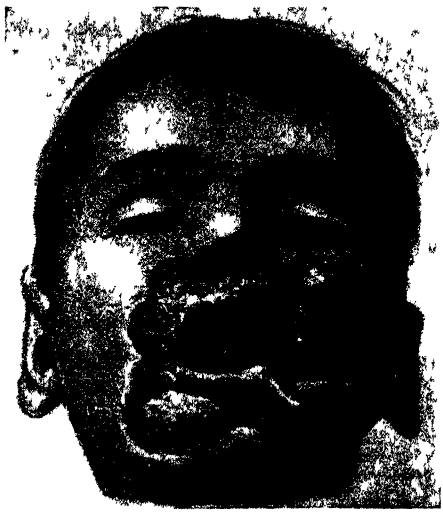


FIG. 52. Cancrum oris.

In the *treatment* of boils and carbuncles on the face, unnecessary manipulation and handling are to be avoided for the above reasons. Incision should be avoided if possible, but should it appear a necessity a simple crucial incision should be made without any attempt at squeezing or scraping the lesion. Excision is not often possible.

Acne and Sycosis are common on the face; the former is due to chronic staphylococcal infection of the sebaceous glands and gives rise to multiple pustules with red raised bases: an autovaccine will cure this usually. In the latter condition the hair follicles of the beard are infected and the hairs become matted with a purulent discharge. Depilation by means of X-rays or occasionally electrolysis and vaccine treatment will remedy this.

Septic Cracks and Fissures occur usually in the middle of the lower lip as the result of cold and frosty weather. Such a crack is really a small ulcer and will become hard, painful, indurated and liable to bleed, while it is continually being torn open by the movements of the mouth. It may in the end give rise to lymphatic obstruction and thickening of the lip, or even to epithelioma. If local applications in the form of antiseptic creams fail to heal it, the crack should be anæsthetised with cocaine and scraped or excised.

Cancrum Oris (Noma, Gangrenous Stomatitis). This is an infective gangrene of the soft tissues of the lips and cheek which occurs in young children of poor vitality, especially those who live in large cities and are recently recovering from measles or some other fever; it is rarely seen nowadays. It commences as an infection of the mucous membrane through an abrasion which spreads, and soon a grey slough forms on the inside of the cheek with a foul smell and discharge. The gangrene spreads and the cheek becomes swollen, tense and shiny, while frequently the skin becomes black and sloughs as the process spreads right through the whole cheek. Cases have been recorded in which the process has spread to the tongue, palate, and bones of the face and jaw, which necrose in turn. The child is usually in a profoundly toxic state, and though the temperature may be high, with rigors, it is frequently subnormal and the child collapsed, while there is a grave risk of its developing septic pneumonia, septicæmia, pyæmia, or intracranial infections. Infection in most cases probably is due to Streptococcus pyogenes, often accompanied by Vincent's spirilla, and by spirochætes.

Treatment. The prognosis is very bad, and the only treatment likely to be of any avail consists in freely excising all the sloughing and infected tissue under anæsthesia. The mouth and throat are protected, and the bare edges of the wound are then cauterised with pure carbolic or nitric acid, which should be neutralised at the end of the operation. Necrosed bone must be removed and the mouth afterwards kept as clean as possible with antiseptic mouth washes, while the child is given nourishing food and stimulants. Extensive scarring and deformity may follow this procedure, and this will have to be made good later on by means of plastic operations. Sulphanilamides must be given.

Carbuncle of the Lip. This is a dangerous condition which is due to staphylococcal infection of the soft tissues of the lip, resembling an ordinary carbuncle. It may commence in a scratch or sting, and rapidly gives rise to an intensely painful and marked swelling of the whole of the lip with a spreading œdema of the face. The condition is particularly liable to lead to infection of the intracranial sinuses, or to general septicæmia as a result of implication of the facial veins. It may resemble anthrax closely (see Vol. I., Ch. VIII.). Operation should be avoided if possible and the case treated with hot bathing and vaccines when localisation has occurred. Localisation may be hastened, and cure effected, by injection of about 20 c.c. of the patient's blood at intervals into the subcutaneous tissue around the original lesion.

Glanders and *actinomycosis* also are seen on the face occasionally, having spread thither from the nose or the jaw respectively.

Syphilitic Disease of the lips is not uncommon.

(*a*) *Primary Chancre.* The lip is the commonest site of extragenital chancre, the lesion being seen here most commonly on the upper lip, usually half-way between the middle and corner of the lip. It is said that the infection in this situation usually occurs from infected drinking vessels or pipes or by kissing, but there are other methods by which this may come about. Such an extragenital chancre is atypical, and on the lip it usually starts as a crack or fissure, and soon presents itself as a rounded firm ulcer with slightly everted edges surrounded by an extensive zone of infiltrated tissue, which somewhat resembles œdema, and which may involve the whole lip and usually leads to great eversion of the lip. The induration and hardness are not marked, but this soft infiltration is very extensive, while the ulcer discharges a thin, watery sero-pus. Marked enlargement of the submaxillary and submental glands occurs, while the secondary signs and symptoms develop comparatively early. Such a chancre may resemble an epithelioma, but develops more rapidly, involves the glands sooner, and these are softer and more mobile, while the ulcer is more flattened and less irregular and the tissues around less indurated but more infiltrated. The appearance of the secondary signs and symptoms soon settles the diagnosis. Chancres occasionally are seen also on the eyelids.

(*b*) *Secondary lesions* are common on the lips in the form of mucous patches and snail track ulcers, both involving the mucous membrane. Condylomata are seen occasionally at the angles of the mouth, while the secondary rash is well marked and usually pustular on the forehead (corona veneris).

(*c*) *In the tertiary stage* gummata with deep serpiginous ulceration occasionally occur, while one form of macrocheilia is syphilitic (see p. 158). This usually affects the lower lip, which becomes thick, hard, everted and swollen as the result of a diffuse fibrosis, due to gummatous infiltration. Gummata are especially common on the nose and forehead.

(*d*) *In congenital syphilis* deep cracks and fissures occur on the lips and frequently give rise to persisting scars radiating from the corners of the mouth and known as rhagades.

The treatment of these conditions is that of syphilis in general.

Tuberculosis. The face, lips and mucous membranes of the nose and mouth are common situations in which tuberculous *lupus* occurs. The disease commences as a series of warty, apple-jelly nodules, which spread slowly over the face and leave behind them a healed puckered scar, which is always liable to become epitheliomatous and causes gross deformity and destruction of tissue (see Vol. I., Ch. IX.).

The bones of the face are not uncommonly involved by *tuberculous caries*, the malar bone, the zygoma, and the outer margin of the orbit being the most common situation. Its pathology, diagnosis and treatment are that of tuberculous caries in general; the condition frequently gives rise to tuberculous cold abscess, as also does a tuberculous infection of the preauricular glands.

Tuberculous ulcers similar to those seen on the tongue (see p. 196) occur in the mucous membrane of the lips in patients suffering from phthisis. They are superficial and very painful.

Macrocheilia. This is a condition of hypertrophy of the lip which may affect either lip, but most commonly the lower one.

(*a*) A congenital form occurs which is due to a dilatation of the lymphatic spaces, which are surrounded by an overgrowth of fibrous connective tissue, analogous to that seen in macroglossia (see p. 191), the condition really being one of lymphangioma. The condition is seen in mental deficients, and the lip becomes thick, rigid, firm, protruded and everted, while it may be two or three times its normal size; sometimes ulceration will set in, while attacks of inflammation are frequent. A plastic operation with the removal of a "V"-shaped piece is the best treatment. Another form of congenital macrocheilia is due to nævus.

(*b*) A tuberculous form occurs in children and adolescents: here most frequently the upper lip is involved by a chronic lymphangitis, surrounded again by œdema and fibrosis and thought to be the result of tuberculous infection of chronic cracks and fissures; it is often accompanied by enlarged cervical glands. The lip usually will diminish in size as the result of general anti-tuberculous treatment.

(*c*) Both the foregoing forms occur in children, but in adults the condition is almost always the result of tertiary syphilis, in which case it reacts readily to antisyphilitic treatment (see Vol. I., Ch. VI.).

Herpes Labialis. This is a condition which may be seen on either lip and takes the form of a herpetic eruption consisting of a number of vesicles on red and inflamed bases, which become transformed into pustules and then burst, dry up and scab over. It is seen in children in association with colds, but is especially indicative of pneumonia and pneumococcal infections. No treatment as a rule is required.

Molluscum Contagiosum. This is an infective condition which passes from one child to another and gives rise to round pearly white swellings, umbilicated, and of any size up to that of a pea ; they are often multiple and are seen on the face, lips or eyelids. The cause is unknown, and the best treatment is excision or incision and curetting (see also Vol. I., Ch. IX.).

Tumours and Cysts. The tumours and cysts found on the lips and face are the same as those found on the skin elsewhere ; thus nævi are common, adenoma, plexiform neuroma, sebaceous and dermoid cysts, melanotic sarcoma and warty growths are frequent (see Vol. I., Ch. IX.). These latter are especially seen on the lower lip, where they may resemble an epithelioma. They do not, however, ulcerate, bleed, involve the lymphatic glands or give rise to any infiltration of the tissues round. They are best removed as they may become malignant.

Dermoid Cysts. These are specially common on the face ; they may occur along any of the lines of embryological fusion (see Vol. I., Ch. VIII.), but are mostly seen at the outer angle of the orbit or at the root of the nose. They are not adherent to the skin, but frequently are surrounded by a small bony ridge. They should be excised.

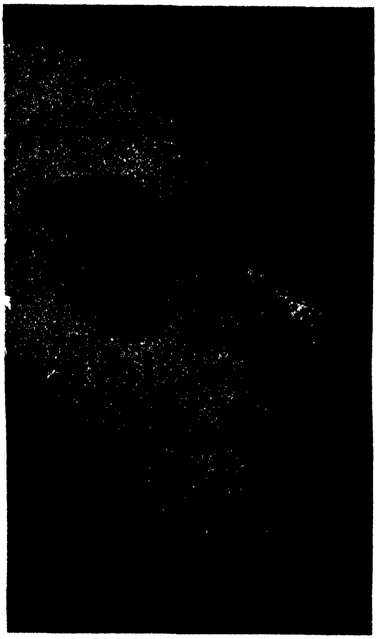


FIG. 53A. Large fungating rodent ulcer of the nose, treated by application of a radium plaque for twenty-two hours daily for ten days.

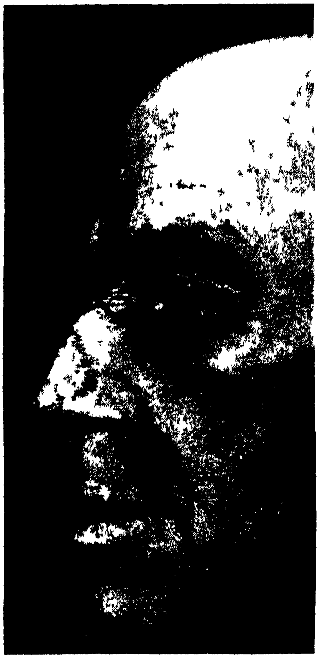


FIG. 53B The same case three months later, after treatment ; complete healing followed further plaque treatment.

Mucous Cysts occur in the mucous membrane of the lips and cheeks as the result of the obstruction to the ducts of mucous glands, and give rise to small, round, bluish, translucent, fluctuating swellings. They should be dissected out. A ranula is an exaggerated form of this condition (see p. 213).

Rodent Ulcer. The face is the most common situation of this growth, which is a variety of glandular cancer, possibly commencing in the sweat or sebaceous glands, usually in patients over forty and especially on the upper part of the face. Some authorities regard it as a basal-celled carcinoma of the skin. It consists of columns of small epithelial cells, which are rounded and closely packed without prickle cells or keratinisation and which grow down into the deeper tissues. In each of these columns the outer cells which surround it are always elongated and larger than the central cells, while cell nests do not occur; the columns are surrounded by masses of new-formed vascular connective tissue. The growth starts as a hard papule or nodule in the skin, which gradually infiltrates the deeper tissues, but ulceration often does not occur for a year or so. When the ulcer is fully formed it spreads in all directions with a raised indurated and rolled edge and a base which is firm, hard and covered with dry, red, glazed granulations often arranged in wave-like forms. There is a firm induration round the edge and base, which does not, however, extend far into the surrounding tissues, and no discharge if it remains aseptic. Attempts at healing and scarring occur in the central parts, but the ulcer increases in size steadily and slowly, often taking about three years to reach the size of a sixpence, while every tissue it comes in contact with is destroyed and eaten into, including the eyeball, nasal cavities, the bones and even the brain. There is no pain in the early stages, and the lymphatic glands are not involved. After the disease has been in existence for many years it exhibits a tendency to become more malignant and more like an epithelioma in type (see Vol. I., Ch. IX.).

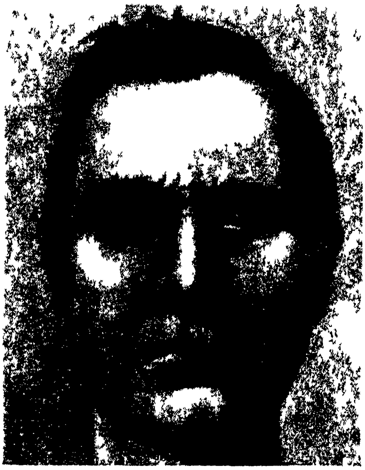


Fig. 54. Advanced sprouting epithelioma of lip.

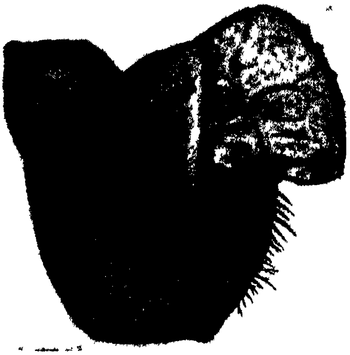


Fig. 55 Lower lip, showing an epithelioma of the sprouting granulomatous type.

Treatment. This should consist in free excision if this is practicable, and when the growth is small. The use of caustics has been given up, as it is found that radium, X-rays or carbon dioxide snow will effect a cure frequently in cases which are too extensive for excision, especially in the superficial growths, while the deeper ones may react to radium (see also Vol. I., Chapters IX. and XXIII.).

Epithelioma of the Lip. This is a common condition, being of the squamous-celled variety, and is confined almost always to the lower lip of men of over forty. It is undoubtedly due in some instances to smoking a short clay or hot pipe; the few women who have contracted the disease have nearly always been smokers of clay pipes ; in other instances it has followed upon a syphilitic lesion or a chronic crack or wart. It is a disease chiefly of the working classes and of country dwellers. A few instances have been reported in which it has been the result of a sharp or carious tooth. It appears in several forms :—

(1) As a hard wart-like nodule, usually between the midline and the angle of the mouth. This wart is indurated, bleeds readily and soon ulcerates.

(2) As a hard or indurated crack or fissure in the lip which spreads to form an ulcer.

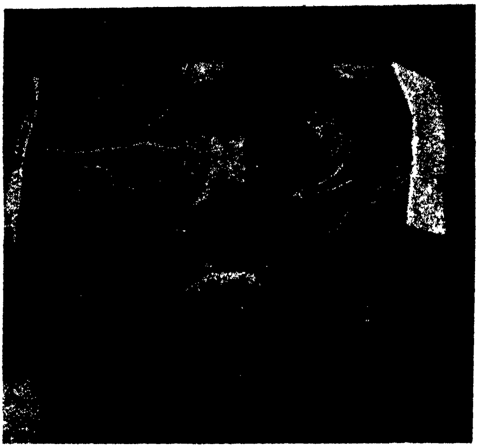


FIG. 56. Epithelioma of lip treated by implantation of radium in needles.

(3) As a typical malignant ulcer with hard, firm, everted edges and extensive infiltration of the tissues round.

(4) As a raised mass of hard, red granulations, which sprout and grow over the lip.

(5) Occasionally as a diffuse infiltration of a large portion of the lip, which becomes hard, nodular and shrunken.

The condition steadily advances and ultimately involves the greater part of the lip, forming a hard, indurated mass with much infiltration round, while the ulceration spreads chiefly towards the angle of the mouth and down the chin. The ulcer is very painful and there will be a watery sanious discharge, while in time the jaw, the mucous membrane and gum will be invaded. The submental and submaxillary glands are soon involved, and finally the deep cervical glands will become infected also, but visceral metastases are very rare. The glands assume the typical appearance of malignant glands. The disease proves fatal if untreated in about three and half years, death usually being the result of the secondary growths in the neck and due to pain, exhaustion, sepsis or hæmorrhage. The diagnosis is usually easy, though simple warts may occasionally give rise to difficulty. If there is any doubt a piece should be examined microscopically.

On the upper lip the disease is far less common, and is seen equally in the two sexes. Its clinical appearance, methods of spread and symptoms are exactly the same, though it is probably less malignant, and is due sometimes to an infection by direct contact from a similar growth on the lower lip.

Treatment. This is one of the few situations where radium treatment gives good results, and the insertion of needles around the growth should be carried out as detailed on p. 207 and illustrated in Fig. 56. Operative treatment consists in early and complete removal of the primary growth with a considerable portion of the lip round it and removal of the lymphatic glands in the neck, including the submaxillary, submental and carotid glands. The excision of the growth should consist of a ⊔ or U-shaped portion of the lip, the edges of the incision being quite half an inch away from the growth in all directions. V-shaped excision is to be avoided, as it will cut across infected lymphatic vessels. The lip is usually then easily repaired without cutting any flaps, but if necessary there should be no hesitation in removing the whole of the lip right down to the chin and then performing a plastic operation for the formation of a new lip. The glands are best removed by a block dissection of the neck as described on p. 208. Recurrence on the lip is rare, but in advanced cases this will occur frequently in the glands. The prognosis if the operation is performed early is good, as the disease appears to be far less malignant than epithelioma of the tongue.

Epithelioma of the Cheek. Epithelioma also starts on the inner side of the cheek, often in association with carious and neglected teeth; the condition may increase slowly, but often penetrates rapidly (*Boring Epithelioma*), when the cheek appears brawny and infiltrated, and may be incised for cellulitis. The prognosis is very bad in this latter type, and radium often aggravates the disease.

Epithelioma of the Face. This disease is much more rare on the face than on the lip, but it is seen occasionally in elderly patients on the eyelid or edge of the nose, where it may develop in connection with a pre-existing scar, wart, or septic lesion. It is seen sometimes in workers in tar or paraffin as a sequel to chronic eczema or inflammation of the face. It starts as a hard nodule resembling a wart, which soon breaks down, ulcerates and gives rise to an ulcer with a deep, everted, raised edge and indurated base, sometimes known as a "crateriform ulcer." The glands in the neck are involved rapidly in a way similar to that which occurs when the disease arises in the lip, while as in the case of all squamous epitheliomata, metastases to internal organs are rare. On the face the disease appears more malignant than on the lip.

The treatment consists in excising the growth and associated lymph glands as in the foregoing condition.

THE PALATE

Cleft Palate. The development of both the hard and soft palates has been discussed on p. 150, and, to recapitulate, it has been seen that the palate is formed of the two palatal plates of the maxillary processes and the four portions of the premaxillary bones derived from the frontonasal process, these portions all meeting at the anterior palatine foramen and the process of fusion spreading from before backwards. By a cleft palate is meant a congenital defect of the palate due to these portions failing to unite properly so that a communication exists between the nose and the mouth; the term is not applied to those gaps in the palate which may be due to injury, syphilis, lupus or malignant growths. Such clefts may be complete or incomplete, the incomplete ones always involving the posterior part of the palate. These latter vary in degree from a bifid uvula to a cleft which simply involves the uvula and soft palate. In other cases more or less of the hard palate will be cleft or the gap may extend as far forwards as the anterior palatine canal. In these incomplete clefts the cleft is entirely in the midline, but in the more severe complete types, where the cleft extends forwards beyond the anterior palatine foramen, this anterior part of the cleft ceases to lie in the midline and deviates to one or both sides, passing between the outer side of the premaxillary bone and the maxilla. These cases involve the alveolar margin, and are accompanied by a hare lip, which is single or double, according to whether the cleft in the palate passes to one or both sides of the premaxillary bone. If the condition is bilateral the premaxillary bone is greatly displaced forwards, and may be found attached to the tip of the nose (see p. 151).

Such a cleft varies considerably in width, and it must not be forgotten that the nasal septum growing downwards from the surface of the frontonasal process also has to meet and unite with the palatal segments about the tenth week of intrauterine life. Thus if the cleft is wide the lower end of the nasal septum may remain free and project between the palatine segments, so that the cleft appears double, and in some of these cases the nasal septum is greatly hypertrophied. More commonly, however, the septum becomes adherent to one edge of the palate, usually the right, and this gives the cleft the appearance of being away to one side of the midline.

In all cases of cleft palate the roof of the mouth is highly arched and narrow (a fact which may render operation easier), while it is by no means uncommon for the nasal septum to appear as one continuous slope with the palatal process to which it is united. In addition to failing to meet in the midline, it sometimes happens that the palatal processes do not extend back sufficiently far to enable the soft palate to reach the back of the pharynx and perform its function of shutting off the nasopharynx, and to remedy this defect Wardill and others carry out a pharyngoplasty.

It is now generally accepted that the best results are obtained when a mobile soft palate capable of closing the nasopharynx results from operation to ensure which some form of pharyngoplasty is often necessary in addition to the uranoplasty. The closure of the gap in the hard palate, the chief objectives of the older surgical procedures, is not so essential, indeed some surgeons like Gillies are satisfied to close the gap in the hard palate by means of an obturator after securing careful closure of the gap in the soft palate. Veau has further emphasised the importance of securing union of the mucosa of the nasal septum to that of the palate and much ingenuity has been shown in securing this, an object by no means easy to achieve especially with a broad gap in the palate.

Clinical Features. With an extensive cleft palate an infant is unable to suck, and spoon feeding will be necessary as described on p. 153 ; thus the nutrition of the child may suffer considerably, and very severe cases frequently do not survive, as they are particularly liable to thrush, bronchopneumonia and diarrhœa. If they survive, their speech is very indistinct, the voice having a nasal twang as the air is expelled through the nose ; no letters which require a certain amount of air pressure to be preserved inside the mouth, such as the consonants D, P, T, G, can be properly pronounced ; during speech the air can be heard hissing out through the nose. Taste and smell are much diminished, and the fact that the nasal and pharyngeal mucous membranes are continually exposed to the air renders them particularly liable to granular pharyngitis and catarrh.

Treatment. The majority of these cases require operative treatment to close the defect, and this always should be advised unless the cleft is particularly big and it is thought to be too wide for the flaps to be capable of approximation. The higher the arch of the palate and the greater the slope of the segments and the more narrow the distance between the teeth, the more easy will the operation be, as there will be less traction upon the stitches. In many cases the chances of the patient surviving if the operation is not done are very problematical, and it has to be regarded as a matter of urgency in some instances.

There has been considerable argument as to the best age at which the operation should be performed, and this will to a certain extent depend upon the nature of the operation determined upon. Thus, Lane recommended that his operation should be performed very early, as soon as the child is viable and within a few days of birth ; indeed, it is difficult to perform this operation satisfactorily after the teeth have appeared. Most surgeons are, however, agreed that the objection to this procedure is the smallness of the parts, the delicacy and friability of the tissues, and the fact that so tiny a child is by no means a good subject for an operation, while for the first eighteen months of life a progressive narrowing of the cleft may occur. At the same time it undoubtedly is unwise to leave the operation until the child is commencing to talk, as bad habits of articulation will have been contracted and the faulty speech certainly will persist. We are, therefore, in agreement with the majority of writers on this subject that the optimum time to select for this operation is between the second and third years. The child should be got into the best general condition possible, the nose and throat must be free from disease and infections ; enlarged tonsils are best removed beforehand, but adenoids may be left in situ, as they may help to shut off the nasopharynx. The object of the operation is to close the gap in the hard palate by means of specially constructed flaps, and to close the soft palate, and, as far as possible, to retain its mobility ; if this is to be successful it is essential that the flaps should have a good blood supply, that there should be no tension on them, and that no infection should supervene. The various operations, of which there are many, will be described below. After the operation is over careful voice-training will have to be indulged in, and this is best done by a professional voice trainer. It is quite likely that the defective articulation will persist, even when the cleft is closed, owing to the patient being unable to shut off the nasopharynx with his soft palate from deficiency in the size or mobility of this structure, though the introduction of pharyngoplasty has greatly reduced this. The operation, however, always is beneficial, for it shuts off the nose from the mouth, prevents the food getting into the nose, and the nasal mucus getting into the mouth, diminishes the tendency to pharyngitis, and improves the sensations of smell and taste.

Obturators. In certain cases treatment by an obturator or artificial velum will give better results than operation ; thus when the cleft is very wide and the palate very flat, especially in adolescents and adults, or if the palate is badly scarred, as the result of previous operations which have failed or partially failed, or if the premaxillary bone has been removed, an obturator will probably give better results, this instrument consisting in a plate or plug fitting over the aperture and kept in position by suction. This plate may be made of thin vulcanite or gold, and should never take the form of a plug fitting into the aperture, as this will cause the opening to enlarge. An artificial velum consists of an obturator, with a movable flap at the back of it to close the soft palate, but these latter structures are not usually very satisfactory.

The name Staphylorrhaphy is applied to the operation of closing the soft palate and Uranoplasty to closure of the hard palate.

The first stage in many cleft palate operations will have to consist in replacement of the premaxillary bone. This bone should never be removed, but be replaced as described on p. 154.

Operations for Cleft Palate. Of the many operations the following are those most commonly employed :—

Langenbeck's method of uranoplasty, which is best undertaken between the ages of two and three, as the presence of teeth has no effect upon it. Mucoperiosteal flaps attached at both their ends are detached from the hard palate by making two incisions, each incision passing back behind the last molar tooth and going down on to the lower jaw, and running within a quarter of an inch of the alveolar margin to just in front of the apex of the cleft. The mucoperiosteum is divided down to the bone, and stripped off the hard palate with an elevator which finally intrudes into the cleft. Each flap has then to be detached from the back of the hard palate with curved scissors without damaging its anterior surface, and this must be done thoroughly on both sides or the flaps will not come together. Both edges of the cleft are then carefully pared throughout their whole length; the parts are then ready for suturing, and the pared edges of the flaps are drawn together with sutures. Complicated loop methods and unwieldy needles have been devised for this purpose, all of which are totally unnecessary if the tiny palate needles and Lane's cleft palate needleholder are employed, as by this means the stitch can be passed straight through first one edge and then the other edge of the flap. The stitches should be of silk or fine salmon gut, not of catgut, and it is unnecessary in most cases to employ any form of wire or lead or other metal splints. It is most important to see that the pared edges are exactly opposed, that they are not inverted, and that there is no tension on the flaps. The stitching should be commenced at the back, the uvula being done first, and none of them should be tied until they are all inserted. When the stitches are tied, if there is any tension on the flaps the lateral incisions should be slightly enlarged to relieve this, and, if necessary, the levator palati and anterior pillar of the fauces may be relaxed by fracturing the hook of the palate bone. This is often necessary. If in this operation it is found that the nasal septum is attached to one edge of the cleft, the flap may be raised partially from the septum and this will facilitate the operation.

Brophy's Method. This depends upon a different principle and is an attempt to close the cleft by drawing the whole of the upper jaws together. It cannot be performed satisfactorily after the age of six months, and if there is a hare lip present it is best performed before this is dealt with. The margins of the cleft are pared and three stout stitches of silver wire are passed through the upper jaws just above the palate; lead plates are threaded on the ends of the silver wire, the maxillary bones are pressed together with the fingers until the cleft is obliterated, and the wire stitches are then drawn tight by twisting. This often has to be done in two or three stages, as manipulation must cease as soon as anæmia of the gums appears, so as to avoid the risk of necrosis of the maxilla. A few stitches will be required in the soft palate, and the wires are removed after about four weeks. The operation is by no means free from the risk of necrosis of the jaws and sloughing of the soft tissues; moreover, the defect lies not in the upper jaws but in the palate, and by drawing the upper jaws together the upper and lower teeth will not correspond.

Lane's method and other flap operations are unsound in principle as they produce scarring in the soft palate which is no longer freely mobile; they will not therefore be described.

These operations have all to be performed upon tiny children under a general anæsthetic administered by means of a Junker apparatus with a tube. Special small-sized gags are required, and long-handled instruments are employed. Bleeding may be free; the child's head, therefore, should be kept hanging down over the end of the table or on the surgeon's knees and the mouth kept dry by sponging; a tube attached to a suction apparatus and passed into the nasopharynx through the nostril is of great help. After the operation is over the child is kept in bed with the head flat, and it is best for the mouth not to be touched in any way, neither swabbed out nor sprayed; he must be prevented from putting his fingers in his mouth (see p. 154). Liquids are given to him by means of a spoon in very small quantities for the first twenty-four hours and in increasing quantities later on. Soft foods and slops can be given after the fifth day, and in most cases the stitches will drop out on their own. If they require removal, this may be done on the tenth or twelfth day, if necessary under an anæsthetic. It sometimes will happen that these flaps will break down and separate, either in whole or in part. If complete separation occurs the operation will have to be done again after a few months; but if only a partial separation occurs, leaving only a small gap, this can be closed easily later by turning a small flap over it.

Perforations of the Palate. Apart from the congenital clefts above described, perforations of the hard palate are seen occasionally as the result of injuries, not infrequently caused by the stem of a pipe being pushed through it, from septic lupus, or far more commonly as the result of necrosis of the palate due to tertiary syphilis. In the soft palate, on the other hand, a perforation is more commonly due to epithelioma than to any other cause.

Abscesses on the Palate are common and are usually due to suppuration under the mucoperiosteum in connection with a carious tooth; they are known popularly as "gum boils." In other instances this condition is due to minor injuries caused by a tooth-plate or hard, sharp substances in the food. The mucous membrane becomes swollen, red and tender, while a flattened, rounded swelling appears, which may be observed to fluctuate as pus forms. The condition usually bursts on its own, but may require incising, in which case foul-smelling pus will come out.

Ulceration of the Palate. Many different ulcers are seen on the palate.

(*a*) *Simple septic ulceration* occurs in connection with the various forms of stomatitis (see p. 169).

(*b*) *Syphilitic Ulceration.* The shallow snail-track ulcers and mucous patches of secondary syphilis are frequently seen here, both on the hard and soft palates.

A gumma is common on the hard palate, and commences as a round elastic swelling near the midline. This softens and bursts and a deep ulcer forms, having the characteristic appearance of a gummatous ulcer. The bone is usually involved and necrosis occurs, this being one of the few situations in the body in which syphilis causes necrosis, though the necrosis is largely accounted for by the sepsis. A sequestrum will separate usually, leaving a perforation of the palate, while the nasal septum is often involved, so that there will be an offensive discharge from the nose. The condition is seen both in acquired and congenital disease. The soft palate is sometimes involved in gummatous disease, when it will end by becoming scarred and contracted and often adherent to the back of the pharynx, this condition giving rise to a nasal twang and sometimes leading to blocking of the Eustachian tubes and deafness and pain in the ear. These conditions react well to antisyphilitic treatment, while such perforations are best dealt with either by means of a small operation and turning a small flap over them or by a properly fitted obturator. When the soft palate is adherent to the pharynx, attempts may be made to set it free, but they do not as a rule meet with much success.

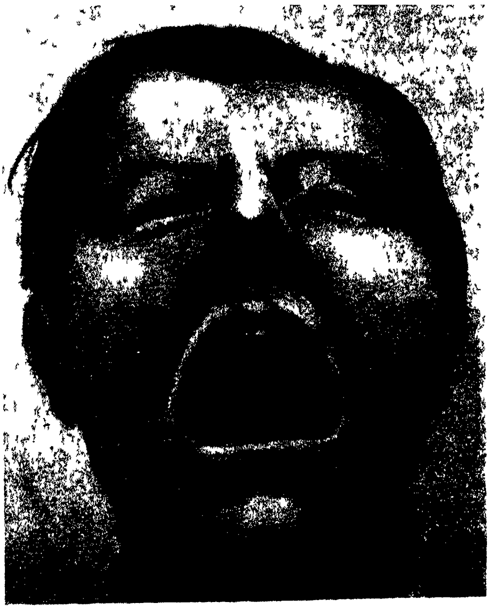


FIG. 57. Old-standing perforation of the hard palate due to syphilitic necrosis.

(*c*) *Lupus.* This occasionally spreads on to the palate from the cheeks, nose or lips, is usually seen in children, and gives rise to great destruction of the soft tissues, and in septic cases of the bones, leading to large perforations.

Actual tuberculous caries of the bone in this situation, with cold abscess formation, is rare.

(*d*) *Malignant ulcers,* usually as the result of epitheliomatous growths (see p. 170). These are more common on the soft than on the hard palate.

Tumours of the Palate. Mucous cysts, dermoids, lipomata and fibromata are very occasionally seen, while simple epulis (see p. 172) may spread on to the palate from the gum. *Papillomata* are seen, and resemble those on the tongue and cheeks. They are often associated with leukoplakia.

An *adenoma* sometimes occurs in the glands of the palate as a smooth pinkish tumour, rather like a cherry, growing slowly and without ulceration pain or glandular involvement; this should be removed by local excision.

Endothelioma occurs in young subjects and appears usually just to one side of the midline, under the mucous membrane, as a round, firm, slow-growing smooth tumour, with an intact mucous membrane over it. At first it does not appear to be malignant, but after being present for some time it may become malignant, grow rapidly, and infiltrate the surrounding structures; at times it appears to be a perithelioma. It should be removed as soon as possible.

Epithelioma is seen especially on the soft palate ; it is sometimes primary, while it frequently involves the palate secondarily by spreading from adjacent parts. It resembles an epithelioma on the tongue and gives rise to a hard, craggy ulcer with raised indurated edges, and glandular involvement of the upper cervical glands. In early cases it may be sufficient to remove the palatal and alveolar processes of the maxilla, but if more advanced, complete excision of the upper jaw will be necessary. Still more advanced cases can be treated by removal by burning them out with a diathermy cautery. Melanotic carcinoma is not unusual in this situation.

Sarcoma occasionally involves the palate, usually spreading there from the alveolus or antrum of Highmore, depression of the palate being one of the first signs of sarcoma of the upper jaw. The description of this condition, with its treatment, will be found on p. 181.

Elongation of the Uvula. This condition is usually the result of a chronic inflammation of the fauces and pharynx, which leads to engorgement and hypertrophy of the mucous membrane. At first it can be relieved by means of astringents and may disappear, but later it becomes chronic and persistent. The latter condition is seen especially in children, in whom the uvula becomes swollen and elongated, tickling the back of the tongue and pharynx and giving rise to a continual hacking cough, especially when lying down, and often to vomiting. The treatment of this condition consists in removing the lower half of the uvula after painting it with cocaine, by pulling it down with forceps and snipping it off with scissors.

THE MOUTH

Stomatitis. This is a common condition and consists of an inflammation of the mucous membrane of the mouth, which may be due to many causes, and is especially seen in children and babies, though rarely in those which are breast-fed.

(*a*) *Catarrhal Stomatitis.* This is the result of a septic inflammation of the epithelium and is usually associated with a septic injury or wound, a burn or scald, with a carious or roughened tooth, or mechanical or chemical irritants, in adults possibly assisted by excessive smoking. In other cases it is accompanied by dyspepsia and constipation, while in children of poor health it occurs in the course of measles and scarlet fever. It is often the precursor of other forms of stomatitis. The mucous membrane becomes congested and swollen in spreading patches, while a thick and viscid mucus is secreted in excess and the epithelium becomes white and sodden and finally comes off in patches, leaving small painful erosions and ulcers.

(*b*) *Aphthous stomatitis* is also seen in unhealthy and badly-fed children, and appears as patches of white exudate scattered about the mucous membrane, which is red and inflamed. After a time the patches run together, coalesce, and the epithelium is shed to form small white ulcers, also very painful.

(*c*) *Thrush.* This closely resembles the foregoing condition, and is met with in children while they are teething in the form of white patches like curdled milk on the lips, tongue and throat. It is due to a parasite known as the Oïdium albicans, which is found in sour milk. It may be accompanied by considerable enlargement of the lymphatic glands, which rarely suppurate. It is seen occasionally in elderly and debilitated adults.

Treatment. The treatment of the above conditions consists in the removal of the source of irritation and sepsis, of intestinal and constitutional derangements, and in improving the general vitality and nutrition of the patient. Superficial ulcers may be touched with silver nitrate, while antiseptic mouthwashes, such as peroxide of hydrogen, potassium chlorate, Condy's fluid, boroglyceride or glycothymoline, should be employed.

(*d*) *Gangrenous stomatitis*, or cancrum oris. See p. 157.

(*e*) *Ulcerative Stomatitis.* This is a more severe form of stomatitis, also seen in feeble subjects with septic teeth or during the acute fevers ; its most characteristic form, however, occurs as the result of the administration of mercury (*mercurial stomatitis*), which may occur either as a trade poisoning or as the result of mercurial treatment. Patients vary considerably in their susceptibility to mercury, and occasionally a single dose will produce stomatitis, especially in those with septic mouths and who smoke to excess. It commences with salivation, the gums soon becoming painful, swollen and spongy, while they bleed easily, assume a purplish colour, and the teeth may become loose and fall out. Necrosis of the jaw actually may occur, while a similar condition is seen in the tongue (mercurial glossitis, see p. 193). The lips and cheeks will become covered with small yellow, septic ulcers, while the breath is particularly foul and salivation is profuse. The condition may resemble closely that seen in association with phosphorus poisoning and scurvy.

Treatment consists in removing the cause and leaving off the administration of mercury. The mouth and teeth must be kept clean with antiseptic washes, while chlorate of potash and dilute hydrochloric acid may be administered together with saline purgatives. The loosened teeth frequently will become fixed as the condition settles down.

(*f*) *Vincent's angina* is a severe form of stomatitis associated often with considerable general malaise, and is due to Vincent's spirillum and B. fusiformis which are found easily in scrapings from the ulcers. There is great œdema and inflammation of the mucosa of the mouth and fauces and the mouth feels dry and sandy. The condition, if untreated, persists for a long time, and may give rise to extensive ulceration of the gums and floor of the mouth ; a condition not unlike epithelioma is produced and some difficulty may in consequence occur in diagnosis. Where any doubt exists a biopsy must be performed before any treatment is commenced.

Treatment consists in the local application of chlorate of potash and intravenous injection of a dose of organic arsenic.

(*g*) Other forms of inflammation of the mucous membranes of the mouth and cheeks are seen in syphilis, gonorrhœa, diphtheria (see Vol. I.), erysipelas, and other streptococcal infections. Leukoplakia and smoker's patches similar to those seen on the tongue (see pp. 194, 195) also occur on the cheeks.

Epithelioma of the Floor of the Mouth. This is a common condition, which may occur either as a secondary extension of epithelioma of the tongue or it may appear primarily on the floor of the mouth, when it usually commences between the front and frænum of the tongue and the gum. It is a squamous epithelioma, which starts as a nodule, grows slowly, and soon gives rise either to a deep, painful, craggy ulcer or to a sprouting mass of raised, hard, red granulations. It early involves the muscles of the floor of the mouth and fastens down the tongue so that it cannot be protruded, while it rapidly becomes adherent to the jaw. The glands are rapidly involved and become hard and fixed. As is the case with cancer of the tongue, it is almost always associated with foul, septic teeth. It is exceedingly malignant.

Treatment. Complete excision of the tissues of the floor of the mouth and part of the tongue will be necessary, while sometimes a portion of the mandible may have to be removed. This is usually best done by means of Syme's operation (see Carcinoma of the Tongue, p. 206), while a block dissection of the glands in the side of the neck will have to be performed. The prognosis is very bad, as this is a particularly unfavourable site and recurrence is frequent. For radium treatment, which is here not very successful, see p. 207.

THE GUMS, TEETH AND JAWS

Surgical Anatomy. The gums, jaws and teeth are intimately connected together, and in many cases the teeth are the starting point of disease in the other structures. That portion of the mucous membrane of the mouth which covers the gums is modified to a certain extent in that it here becomes attached to and incorporated with the periosteum of the bone to form a mucoperiosteum. The teeth with which the surgeon is more concerned are those of the second dentition, as it is rare for disease of the teeth of the first dentition to be sufficiently severe to implicate the jaw and surrounding structures. In the second dentition, however, septic affections from the teeth frequently come before the notice of the surgeon, while it is in this dentition that the characteristic teeth known as Hutchinson's teeth are seen in congenital syphilis.

THE GUMS AND TEETH

Gingivitis, or **Inflammation of the Gums** (Spongy Gums), is a subacute or chronic condition often accompanied by a general stomatitis, and usually the result of septic and dirty teeth, leucocythæmia, scurvy or overdoses of mercury or other drugs. The breath is foul, while the gums become swollen, spongy and congested; they bleed easily and may have shallow ulcers upon them, while the teeth become loose and may fall out. The condition may be regarded sometimes as an acute form of Rigg's disease (see p. 171).

The *treatment* consists in removing the cause and giving general treatment to improve the health of the patient, combined with the administration of such drugs as potassium iodide, quinine, and cod-liver oil. Mouth washes should be employed, those containing alum or potassium chlorate being especially valuable, while the gums should be painted with iodine or silver nitrate, 5 per cent.

Pyorrhœa Alveolaris (Rigg's Disease). This is a chronic form of septic gingivitis which commences round the necks of the teeth, which are usually coated with tartar, and is due to a bacterial infection of the soft tissues of the gum and periosteum in the neighbourhood of the teeth. It is not known whether the actual cause is the deposit of tartar round the teeth or whether it is primarily due to failure of nutrition of the gums. A few or many teeth may be involved, and the disease does not commence usually until middle life. The condition commences by the gums becoming purple or red, swollen and œdematous and bleeding readily. After a short time they shrink and a purulent discharge is noticed, which oozes out from pouches around the necks of the teeth, while the mucous membrane of the gum, though no longer swollen, remains red and congested and bleeds easily. The breath is foul and the tongue coated. After some time the gums shrink further and their soft tissues, together with the alveolar margins, atrophy, so that the neck and the upper parts of the fang of the tooth become exposed and the patient becomes "long in the tooth," with shrunken gums. As a result of this the teeth may loosen and even fall out, so that in some cases a natural cure occurs. This loosening of the teeth is helped by the inflammation spreading deeper into the socket along the periodontal membrane, and when this is so, pressure along the alveolar margin will squeeze out thick yellow pus. This condition has at various times been held responsible for numerous other diseases, both general and local, as the result of the absorption of toxins and organisms either by swallowing them or directly into the blood stream. Such general conditions as pernicious anæmia, osteo- and rheumatoid arthritis, fibrositis, gastric and intestinal disturbances of all kinds, chronic indigestion, gastric ulcer, appendicitis, bronchitis, pneumonia, septicæmia, pyæmia, headache, furunculosis, chronic renal disease, chronic osteitis, and innumerable diseases of the nervous system have been attributed rightly or wrongly to this form of oral sepsis; while locally it has been held to be the cause of certain cases of necrosis of the jaw, tonsillitis, empyema of the antrum, enlarged cervical glands, and cellulitis of the neck.

Another variety of the disease is also described in which the gum and teeth appear normal, but where, upon an X-ray photograph of the gums being taken, absorption of the tooth fangs or the presence of clear spaces round them suggests that a hidden infection is present around the fangs.

The combination of pyorrhœa alveolaris and dental caries which is so commonly seen is known loosely as oral sepsis. All such septic teeth should be removed before any operation is undertaken on the mouth, nose, pharynx or digestive tract.

Treatment. This consists first of all in the removal of tartar and the application of strong antiseptics to the teeth and gums and the pockets between them. Peroxide of hydrogen is specially employed for this, while other mouth-washes and dentifrices may be used. In many cases it is wise to remove the teeth, while the pouches may be destroyed by the galvano-cautery or be emptied and rendered clean by massage and rubbing in a paste of chlorate of potash. In other cases complete extraction of all the teeth is the only remedy. Arsenic and vaccines sometimes have proved helpful.

Hypertrophy of the Gums. This gives rise to a form of overgrowth of the soft tissues of the gum, which sprout up in large polypoid, red masses and almost bury the teeth. It is most common in children, and especially in those who are mentally deficient, while the teeth often appear early and are large and carious. Excision of the masses of soft tissue should be adopted. A somewhat similar condition is seen occasionally as the result of an inflammatory overgrowth due to carious teeth, and with the spongy bleeding gums in scurvy.

Atrophy of the Gums. This occurs as a senile change, and also may be the result of pyorrhœa alveolaris or of locomotor ataxia.

Epulis. An epulis is a tumour growing from the mucoperiosteum of the gum, *i.e.*, from the alveolar process of the jaw, and these tumours are of three kinds :—

(1) **Fibrous Epulis.** This is a fibroma growing from the periosteum and may be associated with a carious tooth or the irritation of a tooth-plate. It most commonly grows from the lower jaw and is frequently pedunculated, being known, therefore, sometimes as a *polypus of the gum.* It gives rise to a big, red, fleshy tumour, painless, firm, elastic and lobulated, with an intact mucous membrane over it, though as the result of irritation from the teeth superficial ulceration may occur.

(2) **Simple Granulomatous Epulis,** sometimes called a false epulis. These consist of masses of granulation tissue, and must be regarded as chronic inflammatory overgrowths which are always associated with a carious tooth, and frequently also with a small flake of necrosed bone on the jaw , they are therefore somewhat similar to nasal polypi. They usually occur on the lower jaw and frequently sprout up between two teeth, appearing as a red, lobular, shining mass of soft granulation tissue, slowly increasing in size and quite painless.

The *treatment* of both these forms of epulis is similar. It is not sufficient merely to remove the growth. The growth must be cut away, together with the carious tooth or teeth with which it is connected. If there is a necrosed flake of bone, this also must be removed either by chiselling or scraping it away, as otherwise the condition is certain to recur. The small cavity left should then be packed with gauze and the patient given an antiseptic mouthwash.

(3) **Malignant Epulis.** These tumours are really osteoclastomata, but may be fibrosarcomata of the periosteum or the periodontal membrane. They are in some ways similar to myelomata in that they contain giant cells. They vary greatly in malignancy, this depending largely upon the amount of fibrous tissue present. They grow more rapidly than the other varieties, do not as a rule spring up between two teeth, and give rise to a firm, red, elastic, sessile swelling, which sooner or later becomes ulcerated and bleeds. The foregoing varieties of epulis are painless, but pain may be a marked feature of the malignant type.

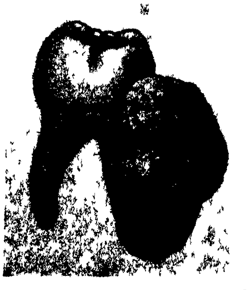


FIG. 58. A carious tooth with a granulomatous epulis attached to it.

The *treatment* of this variety consists in removing the tumour by excising it, together with two or three teeth near it, and a rectangular portion sawn out from the jaw, care being taken not to disturb the continuity of the alveolus. If this is done thoroughly recurrence is rare. Myeloid tumours occur within the jaw, but these should not be regarded as epulides, and are described on p. 180.

Epithelioma of the Gum. Epithelioma may invade the gum secondarily from the tongue, the fauces, or the floor of the mouth, but it not uncommonly commences primarily in that situation as the result of the irritation of a carious tooth or a toothplate. In other instances it appears to have arisen in the socket of a tooth which recently had been extracted. It rapidly invades the bone, and also will fungate and sprout outwards as a mass of firm, raised granulations, while at times it may spread to the cheek, the mucous membrane of the mouth, or the antrum of Highmore. A typical malignant ulceration of the mouth results, and the lymphatic glands become rapidly involved.

The *treatment* consists in the free removal of the growth and surrounding bone together with the lymphatic glands likely to be involved.

Other tumours are rarely seen on the gum, such as adenoma, papilloma, angioma and sarcoma. See also under Tumours of the Jaws, p. 180.

THE TEETH

Those diseases of the teeth which remain confined to the teeth themselves are usually more the property of the dentist than the surgeon, but there are several conditions of the teeth which are liable sooner or later to involve the gums and jaws, when they may be brought forcibly before the notice of the surgeon.

Dental Caries. This form of disease of the teeth is exceedingly common, and is the source of a great many troubles. Caries usually commences in the enamel, when the organisms enter the tooth substance, and it then may spread through the dentine, finally reaching the pulp cavity, where an acute septic inflammation of the pulp will be set up and give rise to severe pain ; there is no specific organism, while the bacterial action is assisted by the formation in the mouth of such organic acids as lactic acid, etc. So far the disease is confined to the tooth substance, but once the pulp is involved the infection is likely to spread down the fang and involve the periosteum round the tooth, giving rise to a periodontitis That this condition is setting in and the infection is spreading beyond the tooth itself is shown by the tooth becoming tender and painful on tapping or pressure, while it tends to project beyond the other teeth so that it catches against the opposite jaw when the patient bites. This is always a sign that the formation of an abscess is not far off, and if the condition progresses further the gum becomes red, dusky and swollen, the cheek œdematous, and pain even more severe.

Alveolar Abscess. This is a very common condition and may be regarded as the next stage in the above-described sequence of events, the infection having spread from the fang of the tooth through the apical foramen ; suppuration occurs round the fang, the alveolar walls become expanded or eroded, and an alveolar abscess forms in the substance of the jaw, continually increasing in size, while the pus may burrow into the substance of the jaw, perforate through it and appear under the periosteum or track up over the edge of the bone and alveolar margin, so that in either case it sooner or later appears in the gum under the periosteum. At this stage it will in some cases burst into the mouth, or sometimes it will strip up the periosteum and burrow far and wide, thus leading to a big abscess and necrosis of the jaw. In other instances the cheek becomes invaded, having previously become adherent to the gum, and the abscess spreads into the cheek and finally may burst on the skin surface, when a sinus will remain after the pus has escaped and lead down either to the carious fang or to a portion of necrosed bone.

This phenomenon occurs most frequently in the lower jaw, when the sinus will be found usually under the front half of the jaw, or even lower down in the neck. In the upper jaw, however, the abscess is liable to open into the antrum of Highmore and infect this, and it sometimes happens that abscesses of this kind in connection with the upper jaw, and especially of the incisor teeth, spread back under the mucoperiosteum of the palate and give rise to a swelling extending some distance over the hard palate. When the abscess has been allowed to burst on to the face, the sinus will persist for a long time until the carious tooth or necrosed bone is removed, and in all cases when it heals it will give rise to a puckered, adherent and ugly scar. Such an abscess gives rise to great pain of a stabbing or lancinating type, rise of temperature and general malaise, inability to open the mouth or eat, while the cheek and face rapidly become swollen, œdematous and red. The cervical glands frequently become enlarged and inflamed, and in some cases a severe spreading cellulitis of the neck may result. Trismus is a common symptom, being due either to the pain and swelling or else to actual infiltration of the masseter; it also may be a reflex muscle spasm.

Treatment. The first point in treatment is that the infected tooth must be removed, and in many cases, especially the early ones, where the abscess is small, this will be sufficient, as it will drain this way. If the condition is rather more advanced and swelling and fluctuation are noticed over any spot on the gum, an incision must be made here, pus let out, and the tooth extracted. No drainage tube or plugging will be necessary usually, but the mouth will need frequent irrigation with peroxide of hydrogen afterwards, as the pus is usually very foul. If possible, incision on the skin of the face outside is to be avoided, but when the skin is thin, red and fluctuating it will have to be incised and the pus let out externally. In many cases the tooth cannot be extracted until the pus is let out and the swelling reduced, for the mouth cannot be opened sufficiently.

The sinus which persists after external drainage will not close until the tooth is removed, and in many cases removal of a sequestrum also will be necessary, this being best accomplished by means of curetting and scraping.

Toothache. This is the result of caries which has progressed sufficiently to have involved the nerve endings in the dentine or pulp cavity; special articles of diet, such as sugar, hot or cold food, etc., cause marked pain. This pain is frequently referred either to the ear, the antrum or the frontal region, and unless the teeth are examined may give rise to misdiagnosis. This must not be confused with the pain set up by a periodontitis or alveolar abscess, in which case the tooth is tender, or with dental neuralgia, which may be due to constitutional causes. To relieve the pain the cavity in the tooth should be washed out and packed with wool soaked in carbolic (1–20), chloroform, bicarbonate of soda solution or oil of cloves.

Impacted Wisdom Tooth. It sometimes happens that a wisdom tooth *becomes embedded or impacted in such a way that it cannot emerge through* the gum. When this is so, between the ages of eighteen and twenty-five it will give rise to considerable pain, both locally and referred to the ear, which is accompanied by tender swelling, redness and congestion at the back of the gum, and in some cases by the development of a clicking jaw or spasmodic *reflex trismus. The condition* is much more common in the lower jaw. An X-ray photograph will make the condition clear, and it can be seen from this whether the tooth is embedded under the gum or actually rotated and impacted behind the tooth in front of it. In the former case an incision in the soft tissues will set it free, while in the latter case it will need elevation and extraction.

Odontomata. These are tumours which arise in connection with the teeth. There are several different kinds which are fully described in Ch. VIII., Vol. I.

Dental Cysts. Two forms of cyst arise in the gum and jaw in connection with the teeth, dental cysts and dentigerous cysts. A dental cyst is common and is a chronic inflammatory collection of opaque fluid which develops in the jaw in connection with the fang of a decayed tooth. These are usually seen in the upper jaw in connection with the bicuspid teeth, and may be regarded as an exceedingly chronic, painless form of alveolar abscess. The cyst consists of a fibrous membrane lined with epithelium and is to be regarded either as an exceedingly chronic abscess due to the infected fang, or possibly as due to proliferation of some part of the enamel organ hitherto not developed which is stimulated to growth by the infection of the fang and which grows and then undergoes secondary cystic degeneration. The fluid is opaque and mucoid and often contains cholesterin and epithelial débris. These cysts growing in the jaw cause a painless expansion of the bone; as the gum becomes expanded its bony wall thins and atrophies until the swelling, hard at first, softens at its central part, and a parchment-like crackling may be felt on pressure (eggshell crackling, see *Vol. I., Ch. VIII.*). Later still the bony wall at one or other point completely disappears, and the cyst then projects as a tense, elastic, fluctuating, bluish swelling around which the edge of the expanded bone can be felt. Occurring most commonly in the upper jaw, it may bulge into the antrum, or it often can be seen as a visible swelling on the cheek. Such cysts are remarkably painless. Such a swelling should never be diagnosed as a dental cyst unless a carious tooth is present or there is a history that one has been removed, as the cyst frequently persists or appears *after the tooth has been removed.* Both this condition and that next described will resemble a sarcoma closely, as in some cases they may give rise to a certain amount of depression of the hard palate.

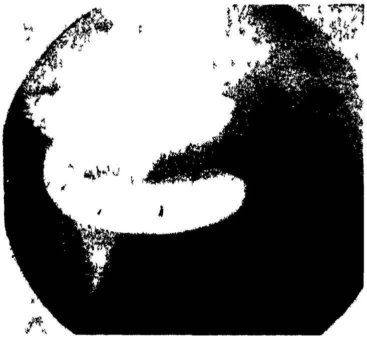


FIG. 59. X-ray photograph of the lower jaw, showing a large clear space in it due to a dental cyst.

FIG. 60. X-ray photograph of the lower jaw, showing a dentigerous cyst containing an unerupted canine tooth.

Treatment. The carious tooth or stump, if present, must be removed; the cyst sometimes will come away with this, or the removal of the tooth may open and drain it sufficiently to cure it. *If this is not sufficient,* the anterior bony wall of the cyst must be cut away, the cyst opened, and its lining scraped out. The greater part of the wall is then removed and the cavity packed with gauze to cause it to heal from the bottom. In the upper jaw care must be taken not to open the antrum.

Dentigerous Cysts. A dentigerous cyst is another name for a follicular odontoma. It is a cyst which arises in the alveolar process of the jaw by formation around a tooth or teeth which have failed to erupt and often have very poorly developed fangs, while the condition is most commonly seen in the lower jaw, where it is usually met with in young people in the neighbourhood of the molar teeth. The cyst is lined with a white fibrous membrane and contains a glairy, mucoid fluid together with the unerupted tooth; it appears as a smooth, rounded, painless swelling which slowly expands the jaw. At first hard and solid, later, portions of the bone become so thinned that they yield on pressure and give rise to "eggshell crackling," while finally, when the bone has become absorbed completely at one or more spots, fluctuation may be obtained there. It will be seen that the physical signs of the condition may resemble a dental cyst (p. 175), but the two conditions usually can be distinguished by the facts that whereas a dental cyst is always associated with a carious tooth, in the case of a dentigerous cyst the X-ray photograph always will show the unerupted tooth or teeth lying within the cyst in the jaw, while absence of one or other of the permanent teeth (that is to say, congenital absence, and not removal by the dentist) is a feature which is almost always present, the only exception to this being that occasionally the corresponding tooth of the first dentition may not be shed, owing to there being no pressure from below to force it out. Occasionally suppuration occurs in a cyst of this kind, when an abscess may form which is frequently followed by a persistent sinus. In some instances excessive fibrosis or even ossification occurs in and round such a cyst, and the condition is then known as a *fibrous* or *osseous odontoma* (see Vol. I., Ch. VIII.).

The *treatment* consists in opening the cyst by cutting away its anterior wall freely from within the mouth, removing the unerupted teeth and the fibrous cyst wall. As much more as possible of the anterior wall of the cyst is then cut away, the cavity packed with bismuth gauze and allowed to heal from the bottom by granulation. In the case of the lower jaw care must *be taken not to fracture the bone in doing this.*

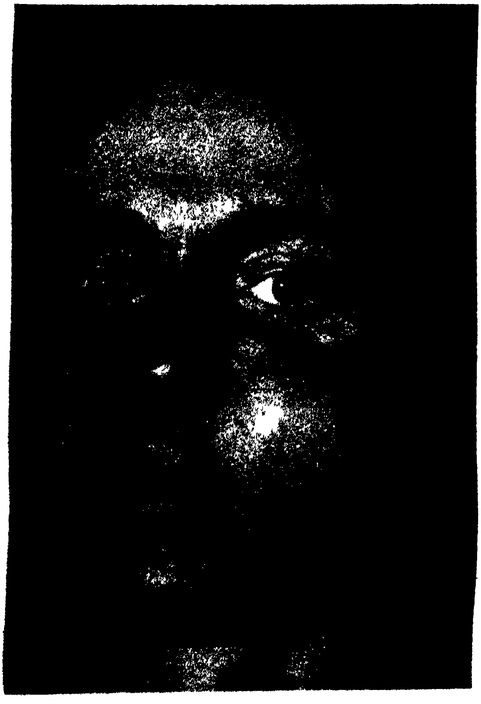


FIG. 61. Patient with a large dental cyst in the left maxilla from a carious premolar root.

Extraction of Teeth. It occasionally falls to the lot of the medical practitioner, however unwilling, to have to extract teeth as an emergency proceeding.

An anæsthetic such as gas or ether is best employed, and the proper forceps for each tooth must be used. When several teeth need removal, those at the back and in the lower jaw are dealt with first. Care must be taken to avoid either breaking the tooth or unduly lacerating the gum and alveolar margin. The sterilised forceps are pushed well up between the gum and the tooth in order to grip the neck of the tooth as high up as possible, and the tooth is then loosened by gently rocking it from side to side, and finally removed by a combination of traction, rotation and inward lateral movement. If care is employed and no violent strain indulged in, the tooth should come out easily without breaking. Special care must be taken in dealing with the fangs of the first and second upper molar teeth, as they are in close relation with the antrum of Highmore and may be forced up into it. Patients should be provided with a carbolic mouth-wash after the operation, and if the gum has been severely torn it should be placed back in position and sutured there with a catgut stitch.

Bleeding Teeth Sockets. Persistent bleeding after the extraction of teeth is by no means uncommon, and though it is especially liable to occur in those who suffer from hæmophilia, scurvy, purpura or high blood pressure, it not infrequently occurs in those who are otherwise perfectly healthy, especially women. Such hæmorrhage is usually the result of severe laceration of the gums or bone. Plugging should be avoided if possible, and styptic mouth-washes, such as peroxide of hydrogen and adrenalin, are employed. If these fail a big plug of cotton wool should be soaked in adrenalin and the patient instructed to lay it on the tooth socket, press it in, and bite on it firmly for twenty minutes or so. This probably will stop the bleeding. If this fails the socket must be plugged formally from the bottom with a narrow strip of gauze soaked in some such styptic as adrenalin, perchloride of iron or peroxide of hydrogen, while in extreme cases, as for instance hæmophilia, the plug should be soaked in a solution of Russell's viper venom.

THE JAWS

Infections of the Jaws. The jaws are involved not uncommonly by pyogenic infections of various kinds, and the mouth being a septic cavity (in many cases extremely septic), infection may invade the jaw bones as the result of fractures of the jaw communicating with the mouth, or from extraction of teeth; also as the result of septic carious teeth in the form of an alveolar abscess (see p. 173), or of cancrum oris (see p. 157), while, finally, the bone may be infected as a blood-borne infection and undergo a typical acute osteitis. In workers who were exposed to the fumes of yellow phosphorus the bone used to become readily infected by septic organisms and undergo an extensive necrosis (phosphorous necrosis, or phossy jaw). The result of a septic infection of the jaw from any of these causes is frequently a necrosis of the jaw, which will be described below.

Treatment. In the early stages of a pyogenic infection of the jaw the treatment consists in letting out pus when it forms, if possible from within the mouth. If, however, the skin is red and the abscess pointing in the cheek, an external incision will have to be made and a scar cannot be avoided. Free drainage should be established and the mouth kept as clean as possible with an antiseptic mouth-wash; carious teeth, if present, should be extracted.

Tuberculosis of the Jaw. This, which usually takes the form of a characteristic tuberculous caries, is rare. It is most commonly seen in the upper jaw, near the orbit and malar bones in weakly children. It was at one time thought that phosphorous necrosis was largely due to the supervention of a tuberculous infection, but this is unlikely. The disease progresses to form cold abscesses, which ultimately burst and give rise to persistent sinuses with a great deal of scarring and puckering round them. The treatment is that of tuberculous caries in general, and operative eradication of the disease usually will be necessary before healing occurs.

Actinomycosis. The lower jaw is the most common seat in the body of actinomycosis, where the disease frequently attacks the region of its angle, the ray fungus probably obtaining access to the bone through a carious tooth. A full description of the disease is given in Ch. VIII., Vol. I. In connection with the jaw the disease is said to be most common in country dwellers, farm labourers, etc., who suck grass or straw, and it commences with vague pain and tenderness in the jaw and teeth, while a swelling forms soon which consists partly of the swollen jaw, but largely, also, of the infiltrated soft tissues round, and soon gives rise to a characteristic cervico-facial growth which is smooth, even and hard, fixed to the bone, of wooden consistence, and merges imperceptibly into the surrounding tissues. It increases in size very slowly, while after a time the skin over it becomes red and dusky, and areas of softening appear in the swelling as suppuration occurs ; yellowish nodules appear in the skin which soften, burst and discharge. Multiple sinuses form which discharge a small amount of thin, watery pus containing the characteristic sulphur granules and in which mycelial elements may be discovered. The bone undergoes cario-necrosis and lies exposed at the bottom of the sinuses, while marked trismus, puckering and disfigurement are caused, the sinuses healing in one place and bursting open in another. The disease usually lasts

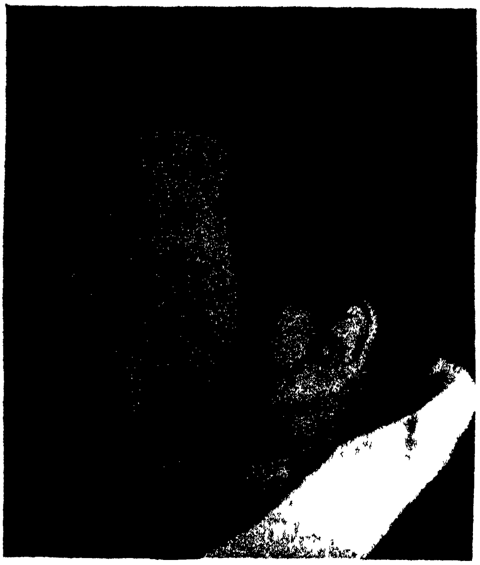


FIG. 62. Actinomycosis.

for several years, and in its early stages may be mistaken for sarcoma or tuberculous disease.

Treatment. This has been discussed in Vol. I., and consists in general of the administration of potassium iodide and sulphanilamides, injection of formalin, surgical attempts to extirpate all the infiltrated and diseased tissues and the insertion of radium.

Syphilitic Disease. This is not common in the jaw, though localised gummata and gummatous periostitis are seen occasionally. In the palate, however, syphilitic necrosis is frequent (see p. 167).

Necrosis of the Jaw. As has already been seen, this may be due to several causes (p. 177). The thin covering of soft tissues over the jaw renders it particularly easily invaded by septic infections, and thus necrosis is common in connection with severe bruises or compound fractures, alveolar abscess, tooth extraction, and in the palate and alveolar borders as the result of syphilis. It is also seen after the radium or X-ray treatment of carcinomata within the mouth. During an acute fever or as the result of grave malnutrition a spontaneous acute osteitis is occasionally seen, and this usually will lead to very extensive necrosis, occasionally involving the whole mandible. **Mercurial poisoning** used at one time to give rise to necrosis of the jaw, but this, together with the **phosphorous necrosis,** is rare nowadays. The latter disease has been more or less stamped out by the use in factories of the amorphous form of phosphorus only. Phosphorous necrosis was of a peculiarly chronic and intractable nature and usually invaded the lower jaw, giving rise to a large amount of deposit of new bone and the formation of large, grey, porous sequestra resembling pumice stone.

The *clinical features* of necrosis of the jaw are, in the first instance, those of acute infection of the parts round with severe pain, great swelling, rigors, high temperature and trismus. Pus soon forms, which may burst or track for some distance into the surrounding tissues, the pus being particularly foul and the sinus formed by its bursting or being let out persisting till sequestra are removed. As a rule very little involucrum is formed in the lower jaw and none at all in the upper jaw, while sequestra form rapidly and can be detected by the probe or an X-ray film. These sequestra separate very slowly, often taking three or four months. The extent of the necrosis varies greatly, ranging from a small superficial flake of bone to an involvement of the whole of the lower jaw. Complications such as intracranial infection or cellulitis of the neck are not uncommon.

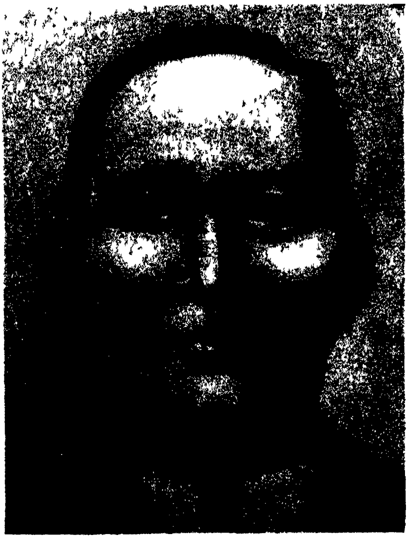


FIG. 63. Sarcoma of the upper jaw.

Treatment. In the early stages this consists of incision and drainage, but later on removal of the sequestrum will be required; this, however, should be delayed until it is clearly loose. If possible the sequestrum should be removed from within the mouth, as little damage as possible

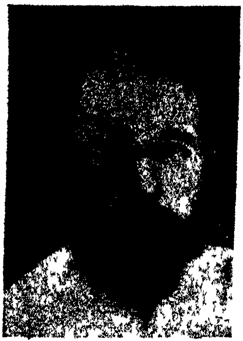


FIG. 64. Fungating sarcoma of the upper jaw in a man of thirty-six. It had been present nineteen years.

being done to any surrounding new bone which may have formed. Free drainage is provided and the mouth kept clean with antiseptic washes, while it is often wise to pack the cavity with bismuth gauze. In the lower jaw, if an involucrum forms, there will not be great deformity, but care must be taken to prevent the jaw becoming fixed by adhesions, scarring or ankylosis of the joint. In the upper jaw no new bone will form and the cheek is certain to fall in. This can be corrected later by the wearing of a dental plate.

Tumours of the Jaws.

(A) **The Upper Jaw.** Simple tumours of the upper jaw are rare; the various forms of epulides have been described on p. 172. Chondromata, fibromata and osteomata are seen very occasionally, the latter occurring usually within the antrum, orbit or sinuses. **Leontiasis ossium** also occurs in this situation, but is probably an inflammatory overgrowth of the bones, due to chronic sinus infection. This latter condition commences in young adults, progresses slowly and continuously, and gives rise to great pain. It affects chiefly the cranial and facial bones, from which there sprout out large masses of spongy bone, giving rise to great deformity. Ultimately the inside of the cranium, the orbits and the nose will become invaded and their contents pressed upon, while at times it spreads back over the whole skull (cancellous hyperostosis of Virchow). The air sinuses become filled up in time and the nose blocked so that loss of smell, loss of vision and exophthalmos will occur. Though the vault of the skull and the mandible may become involved, the base of the skull usually escapes. Strange unilateral cases following the distribution of one or other of the trigeminal nerves have been recorded. No treatment has any permanent effect, though it may be possible to remove some of the more disfiguring masses of bone.

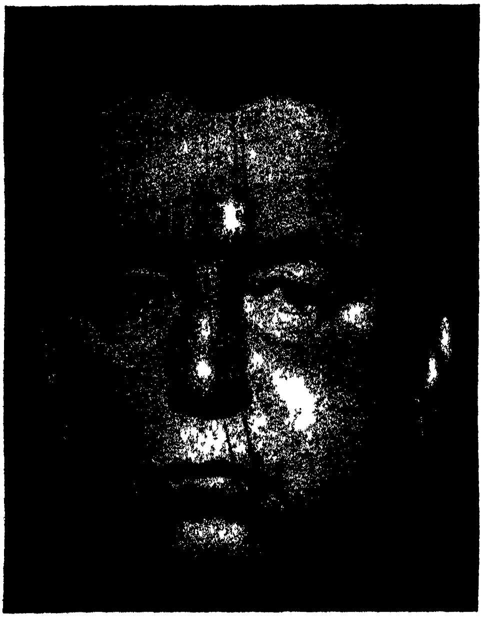


FIG. 65. Carcinoma of the left upper jaw of eight months' duration in a man of fifty-three.

Myelomata (Osteoclastomata) are seen in the jaws, usually arising within the alveolar process. The alveolar process becomes swollen and expanded, dusky and congested, with very little pain. After a time the bone softens and gives rise to egg-shell crackling, while later it may give way and fungation occur. These tumours arise within the alveolus and should not be regarded as epulides; they may resemble closely dental or dentigerous cysts. but an X-ray picture will distinguish them.

Treatment. The tumour resembles osteoclastomata seen elsewhere in the body, and should be treated by free removal together with the surrounding bones. In the upper jaw the growth ultimately may invade the antrum, and it will then be necessary to remove the whole alveolus and palate or even the whole upper jaw.

Malignant Tumours of the Maxilla. Both sarcoma and carcinoma are met with here. *Sarcoma* is the commoner and is usually either round or spindle-celled. It may commence in the spheno-maxillary fossa, growing from the back part of the jaw, within the antrum or from the front wall of the maxilla, while it may invade the jaw secondarily from elsewhere. *Carcinoma* most frequently commences in the epithelium of the gums or palate and invades the jaw secondarily. In this case it will be a squamous epithelioma. In other cases it commences in the mucous membrane of the antrum, when it probably will be a columnar carcinoma unless the epithelium of the antrum has previously become squamous in type, having undergone metaplasia as the result of long-continued chronic inflammation. Certain forms of odontomata may exhibit locally malignant characteristics.

Clinical Features. It is usually impossible to diagnose whether the condition is sarcoma or carcinoma, except that the latter is more liable to involve the lymphatic glands, while those cases which commence on the palate and gums are obvious. It is, however, important to settle from which aspect of the bone the tumour arises, while the malignancy of the growth will be shown by its rapidity, the rapid involvement of surrounding structures, its spread in all directions, and the recurrence after removal. No age is immune.

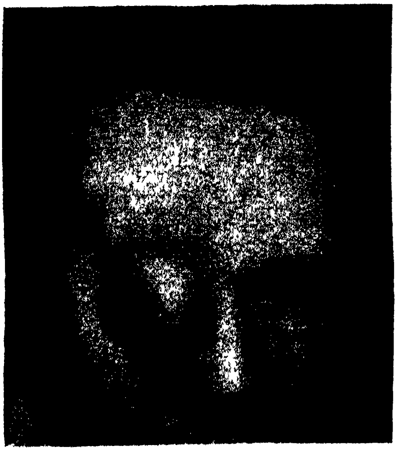


FIG. 66. Endothelioma of orbit.

(*a*) If the tumour grows from the anterior aspect of the bone under the cheek, *i.e.*, probably from the periosteum, it starts as a swelling which pushes the cheek forwards in the first instance, and it is only later that it will invade the mouth, the antrum and the orbit. It, however, can be felt through the mucous membrane under the cheek. In the early stages there is no nasal discharge, no depression of the palate, no epiphora, and no nasal obstruction, but the soft tissues of the cheek soon undergo an infiltration which may rather resemble œdema.

(*b*) If the tumour commences behind the maxilla from the periosteum of its posterior surface, it grows in the spheno-maxillary fossa, and invades the orbit from behind. Thus the eyeball is pushed forwards, while in some cases the whole upper jaw is protruded and a swelling appears in the temporal region. Later the antrum will be invaded and the nose become involved through the palatine foramen. Many cases of this latter type of tumour are really growing from the base of the skull and not from the maxilla itself.

(*c*) Those growths which start from within the antrum may be regarded as the typical malignant tumour of the maxilla, and in fact sooner or later both the other types invade the antrum and take on the following characteristics : the first symptom is usually pain in the fifth nerve, and after a time the antrum becomes distended with growth while its walls are bulged out in all directions; the palate can be seen to be depressed, the cheek prominent, the eyeball pushed up, while softening and eggshell crackling can be felt over the swelling. There will be a foul nasal discharge, with considerable nasal obstruction on the diseased side, while blockage of the lachrymal duct will cause epiphora and the antrum will be opaque on transillumination or in the X-ray film; puncture of the antrum will produce blood and no pus. On examining the nose the ulcerating, fungating growth will be seen. In all cases in the later stages the surrounding tissues become infiltrated and there is severe pain referred to the second division of the fifth nerve. Fungation, with bleeding and discharge, will occur ultimately either into the nose, into the palate or on the cheek. The progress is rapid owing to the great vascularity of the parts concerned, and death is not long delayed.

There are certain conditions which may resemble these growths. For instance, other conditions will give rise to expansion of the jaw, such as myeloids, dental and dentigerous cysts, or to expansion of the antrum, such as a mucocele or occasionally an empyema. But none of these conditions gives rise to the same pain, steady progress, and infiltration of surrounding tissues and the same tendency towards bleeding, discharge and fungation. Care must be taken not to treat one symptom, such as neuralgia or nasal discharge, and fail to discover the cause.

Treatment. This is one of the situations where radium or deep X-ray therapy gives excellent local results, radium being best used in the form of the bomb. This line of treatment should be used in all these cases rather than the drastic surgical procedures which were formerly employed. Should radium be unavailable or fail to give improvement, then some form of removal of the disease is the only practicable treatment for this condition. Fewer cases are seen now in the inoperable stage than used to be the case, but it is not uncommon still to find cases in which excision is unwise. Thus if the growth has spread beyond the limits of the bone into the cheek, or backwards into the sphenomaxillary fissure, it is doubtful if complete excision is possible. Only two operative procedures are advisable : either formal complete excision of the upper jaw or else a less extensive operation, in which the floor of the orbit and the hard palate and alveolus are left behind ; this latter is known as Moures' operation, but it cannot be done in extensive cases. In conjunction with either of these operations, if microscopically it is found that the growth is a carcinoma, the glands in the side of the neck will have to be removed also by a second operation at a later date. The death from inoperable malignant disease of the upper jaw or from local recurrence is more terrible even than in the case of carcinoma of the tongue, for both the palate, nose, eyeball and cheek will be infiltrated and destroyed.

Moures' Operation (*Lateral Rhinotomy*). This operation is devised for the less extensive growths which do not involve the palate, alveolus or floor of the orbit. The incision made is similar to the incision for the removal of the upper jaw, that portion which splits the upper lip being left out, and the flap is turned down to expose the bone. A large opening is then made into the front of the antrum and the antero-lateral portion of the nose by freely cutting away the bone in this situation, the palate, alveolus and floor of the orbit not being touched, and the growth is then removed from within the jaw as completely as possible. After replacement of the skin flap the resulting deformity is very slight. (See also p. 316.)

Excision of the Upper Jaw. This is a more formidable operation, and one which leads to more deformity, but it is not especially dangerous if the anæsthetic is administered by the intratracheal method. For full details a book on operative surgery must be consulted. Ferguson's skin incision is made, which divides the upper lip vertically in the midline, passes round the ala nasi, and between the nose and the cheek in the furrow there present, up to the inner angle of the orbit, where it turns out and runs along the lower margin of the orbit to the commencement of the zygoma. This flap is then turned outwards and should include all the soft tissues down to the bone. The bony attachments of the jaw must then be sawn through, but before this is done the periosteum should be raised from the floor of the orbit as far back as possible, the nasal cartilage should be detached from the nasal process of the maxilla, and the central incisor tooth be extracted from the jaw to be removed. A narrow keyhole saw will be required, and with this the nasal process of the superior maxilla must be sawn through, the cut extending through the floor of the orbit as far back as possible; the malar bone is sawn through, this cut extending right into the sphenomaxillary fissure, and finally the saw is passed in through the nostril and the alveolus and hard palate divided. Assistance in these cuts sometimes will be obtained by narrow bone forceps, with which the back portions of the bones can be divided, while great care must be taken not to damage the eyeball or the soft palate, the former being protected by a broad retractor. The soft palate should then be detached from the back of the hard palate, and the bone now will remain attached only by the pterygoid process and the lateral mass of the ethmoid. The bone can then be seized by lion forceps, one blade gripping the alveolar process and the other the orbital margin, and it can be removed by twisting it out, the remaining bony attachments at the back being fractured. Hæmorrhage may occur at this point from the deeper vessels, but it is easily stopped by plugging the wound with gauze and ligaturing any vessels which seem to require it. The cheek flap is then carefully sutured back into place and the cavity is packed with gauze. This plug can be removed finally within twenty-four or forty-eight hours, and the mouth is kept clean with antiseptic washes, while the large cavity left finally fills up with granulation tissue. The patient at first will require feeding by a tube passed to the back of the pharynx. Subsequently the dentist should fit an obturator to replace the hard palate, with a cheek plate attached to it to prevent the cheek falling in. In some instances where the eyeball tends to fall this can be kept in place by a further attachment to the obturator. Œdema of the lower eyelid is often seen from its lymphatics being cut. Unfortunately, recurrence is only too common.

(B) **The Lower Jaw.** The same varieties of simple tumour are met with here as in the upper jaw; thus osteoma, chondroma and fibroma all occur, the only one of these which is at all common being the osteoma, which is sometimes found growing at the back of the mandible in the neighbourhood of the canine tooth. It does not usually attain a great size or give rise to any trouble.

Myelomata (Osteoclastomata). Myelomata are comparatively common in the mandible, where they usually start inside the alveolar process, giving rise to expansion of the bone. Such a tumour grows slowly and does not tend to infiltrate the surrounding tissues or involve the glands; it sometimes produces a pathological fracture. As it increases in size it will pass through the stages of expansion of the bone, thinning of the bone with eggshell crackling, and finally fungation.

Treatment. These tumours should be removed if possible by cutting away the outer surface of the bone over them and scraping the tumour out, the cavity being subsequently swabbed out with pure carbolic. If it is more extensive or recurs after this, resection of the portion of the bone involved should be performed. A bridge of bone should be left, if possible, to connect the two sides of the jaw, as otherwise great deformity and discomfort will be caused, and this is nearly always feasible. If the whole thickness of the bone has to be excised, a wire splint or bone graft should be introduced at once to hold the fragments apart, and later on a dental plate will have to be fitted.

Fibrocystic Disease (Epithelial Odontoma). This is described fully in Vol. I., Ch. VIII. It occurs usually in young people, in whom, though it is not malignant, it may give rise to a rapidly growing tumour, ultimately attaining a great size and consisting of cystic spaces lined with well-formed epithelium and containing clear fluid. It is seen in either jaw, but most often in the mandible. The affected portion of the jaw should be removed.

Malignant Tumours of the Mandible. Periosteal sarcoma and epitheliomata are seen here. The former is very malignant, grows rapidly, shows the same tendency to ossify as in the case of other periosteal sarcomata, and soon fungates and gives rise to metastases.

The latter spreads into the mandible after having commenced on the mucous membrane of the gums, lips, fauces or tongue; occasionally it arises in the socket of a recently extracted tooth. It soon infiltrates and rapidly extends into the bone, which ultimately will become carious and expanded, and involvement of the lymphatic glands soon occurs. Many cases must be regarded as inoperable, but, if possible, complete excision of half the lower jaw, together with the lymphatic glands, should be performed. Radium treatment is sometimes successful here. For its details see p. 209.

Excision of the Lower Jaw. This is an operation rarely performed; it consists in the removal of the whole of one side of the jaw, and is occasionally necessary for extensive malignant growths or for necrosis. For full details a book on operative surgery must be consulted. An incision is made vertically down the middle of the chin, not reaching as high as the red margin of the lip. Below the symphysis it passes along the under surface of the jaw, at the angle turning up to the lobule of the ear. The flap is then turned up and dissected off the bone, the facial vessels tied and cut, the soft darts dissected off the bone, and the mouth opened into. The jaw is sawn through in front a little to one side of the middle line, the bone is rotated outwards and the soft tissues attached to its internal surface cut through. The masseter and temporal muscles are divided close to the bone, and after the pterygoid muscles have been cut the joint is disarticulated. Then the bleeding is stopped and the soft tissues sewn together. This operation will lead to considerable deformity and discomfort.

Fractures of the maxilla and the mandible, dislocation of the temporo-mandibular articulation, and internal derangement of this joint are discussed on pp. 185, 188. Diseases of this joint, including tuberculosis, septic arthritis, and osteoarthritis, are discussed in Vol. I., Ch. XX.

Fixation of the Mandible. Immobility of the jaw in a closed position is a not uncommon condition, and one leading to great discomfort. This fixture may be temporary or permanent.

Temporary fixation (*trismus*) will be due to spasm of the muscles of mastication, and is frequently reflex as the result of the irritation of carious teeth, unerupted wisdom teeth, or infective lesions in the neighbourhood, such as necrosis of the jaw, parotid abscess, septic glands, tonsillitis or parotitis. In other cases these inflammatory lesions render it impossible to open the mouth from the pain and swelling associated with them. Growths of the tongue, jaw, fauces and soft tissues round may from their very size prevent opening the mouth. Temporary fixation of the jaw is sometimes the result of occupation cramp in speakers, hysteria, tetanus or acute rheumatic fibrositis.

Permanent Fixation. Permanent fixation of the jaw is due to other causes. Very commonly it is caused by true ankylosis of the temporomaxillary joint as the result of gonorrhœal, pyæmic or tuberculous arthritis. This is known as intrinsic ankylosis and may be fibrous or osseous. In other cases (extrinsic ankylosis) the fixity is not due to conditions involving this joint at all, but may be the result of scarring and contraction of the soft tissues of the cheek (either the skin or muscles), which may be the result of burns, lupus, rodent ulcer or other malignant infiltration, cancrum oris, operative procedures, or fractures of the jaw. Gummatous infiltration or fibrous degeneration of the masseter occasionally occurs as the result of syphilis or other infections. There will be interference with the power of mastication and speech and difficulty in the introduction of food into the mouth ; this, however, often can be done through some gap between the teeth. The mouth cannot be kept clean, so that caries of the teeth and oral sepsis are liable to follow. In those cases where the fixation is due to disease of the temporomandibular joint, and especially if actual ankylosis has occurred here, deformity will be noticeable, as in many cases the whole jaw is displaced backwards, and, if the condition has occurred in childhood, is imperfectly developed, with the result that the prominence of the chin is absent, the jaw is receding, and the lower teeth lie considerably behind the corresponding ones in the upper jaw.

It must be remembered that ankylosis of one joint is sufficient to fix the whole jaw, and this being so it is sometimes difficult to tell on which side the ankylosed joint is.

Treatment. In the case of temporary fixity of the jaw removal of the causative condition will effect a cure, while the jaws can be forced gradually apart under an anæsthetic by a gag, wedge or dental prop. In other cases the treatment depends entirely upon the structures affected and the cause. If the condition is clearly due to ankylosis of one of the joints it is best to resect the condyle of that joint or divide the neck of the bone, in either case implanting a flap of the temporal muscle between the bony surfaces. If due to scar tissue in the cheek, division of the scar tissue or plastic operations are usually unsatisfactory as the condition rapidly reforms, and in these cases the best treatment is undoubtedly either to form an artificial joint in front of the scar tissue by excising a wedge-shaped portion of the jaw there and interposing a flap of muscle, or else removal of the whole of the vertical ramus of the jaw down to the angle. Either of these operations gives satisfactory results. In these permanent cases forcing the jaws apart with a wedge under an anæsthetic is usually unsatisfactory, and it may lead to fracture of the jaw, as this is liable to be atrophied from disuse.

INJURIES OF THE JAWS

Fractures of the Lower Jaw. These are produced as the result of direct violence, such as horse kicks, falls or blows upon the point and side of the mandible. All such fractures should be treated in consultation with a dental surgeon.

The commonest site of fracture is through the dental foramen on one or both sides, as the jaw is weak and narrow at this spot owing to the large socket for the canine tooth. Bilateral fractures are by no means uncommon ; in this case the break usually runs obliquely downwards and outwards, and on one side may lie just in front of the masseter.

If the fracture is unilateral the posterior fragment on the fractured side is usually pulled upwards and forwards by the masseter and overlaps the anterior fragment, but in bilateral fractures the anterior detached portion passes downwards and backwards, being pulled down by the hyoid muscles, while the posterior segments are tilted upwards and outwards. All these fractures are essentially compound, as the mucous membrane of the mouth and gum is nearly always torn. Occasionally fracture at the symphysis will be seen as the result of compression of the jaw; this is also compound, but the displacement is very slight. In other instances the angle or ascending ramus is fractured; in this case the fracture is less likely to be compound, while the deformity is much slighter as the masseter and other muscles around hold the bones in position.

The more rare type of fracture which may follow a fall on the chin or other blow consists in a break of the condyle or rather a fracture just below the condyle, this latter portion being tilted inwards and forwards by the external pterygoid, while the rest of the jaw passes upwards and towards the injured side. In very rare cases the coronoid process has been snapped, while the condyle has been driven through the glenoid cavity and fractured the base of the skull. In these last three high-up fractures the diagnosis may be impossible without an X-ray film.

Clinically the amount of displacement will be best ascertained by noting the irregularity of the teeth line, this irregularity being obvious. The patient assumes a characteristic attitude, holding and steadying the fractured jaw with his hand while he has difficulty in speaking and swallowing, and the saliva may run out of the mouth. Pain is very marked, especially if the dental nerve is pressed upon, while deformity, abnormal mobility and crepitus may be detected easily. Bleeding at the mouth occurs, and this may be profuse. If the fracture is in the neighbourhood of the condyle all the signs are less obvious and pain is less marked, except when the jaw is opened. The displacement, however, is obvious, and a marked swelling, due to a hæmatoma, will form in the parotid region.

Treatment. As a temporary measure the fragments can be kept in apposition and approximately fixed by means of a firm four-tailed bandage. If there is no displacement this will do well as a permanent measure, but in all cases it is useful as a first-aid method. Care must be taken that the lower and back part of the bandage does not drag the fractured fragment backwards, while the patient is fed by a rubber tube passed behind the last molar tooth; in this method we are really utilising the upper jaw as a splint, and the mouth, therefore, should not be opened. In most cases the co-operation of a skilled dentist should be obtained, while all teeth which are markedly loose or are septic should be removed; if only slightly loose they should be kept, as they will become refixed. Care must be taken to eliminate the possibility of a tooth being fixed between the fragments. The greatest attention must be paid to the hygiene of the mouth and frequent antiseptic mouth-washes ordered, for the fracture being compound, suppuration is liable to occur, but it should not lead to necrosis if properly kept under control by means of mouth-washes.

If displacement has occurred it must be corrected as soon as possible, and the fragments be held in position by some such apparatus as Gunning's splint. This is fitted by means of a cast taken of the jaw and teeth and consists of an interdental splint of non-corrosive metal moulded to fit over the crowns of the teeth in the lower jaw. In some cases this will permit of movement of the jaw, while in others a second splint is fitted to the upper jaw, to which the lower splint is fixed. In a few cases the deformity is so difficult to correct that operation for drilling or wiring will be necessary, while if gross loss of bony substance has occurred bone grafting will be required subsequently; but this cannot be undertaken until all sepsis has died down and the wound has healed. Bronchopneumonia and secondary hæmorrhage are occasionally seen as later complications. After three weeks all fixation of the jaw can be removed and massage and movements permitted. Union nearly always occurs in about five weeks unless a loose tooth has become impacted between the fragments. Every possible measure must be taken to prevent malunion, as this, by altering the alignment of the teeth, interferes with mastication; but even if this occurs, in the course of months or years the shape of the jaw will be largely restored, presumably by the tongue and muscles round exercising constant pressure upon it.

Fractures of the Upper Jaw. These are the result of direct violence such as gunshot wounds, blows and horse kicks, while the fact that the fractures are liable to open into the mouth, nose or antrum of Highmore means that they will frequently be compound. In some cases the alveolar process, and in others the whole upper jaw, or even both upper jaws, are rendered loose by a severe kick, while these gross injuries are liable to be complicated by damage to the nose and nasal bones. Small portions of the alveolus are often snapped when teeth are extracted.

In connection with fractures of the upper jaw many complications may arise according to which portion of it is damaged. Thus the nasal duct or lachrymal sac may be involved, and in this case epiphora or surgical emphysema may follow. There may be severe hæmorrhage from the big vessels of the face, or damage to important branches of the fifth nerve. Suppuration, necrosis and infection of the antrum of Highmore sometimes will supervene, while in other cases the base of the skull also will be fractured.

The **malar bone** and **zygoma** are sometimes fractured as the result of blows; the fracture is usually obvious, though afterwards it may be obscured by the amount of swelling.

Treatment. The mouth must be kept as clean as possible by means of mouth-washes, while any deformity present must be corrected as far as possible, as otherwise the apposition of the upper and lower teeth and proper mastication will be interfered with. In many cases this will require the assistance of a skilled dentist. In most cases no fixation will be required other than a four-tailed bandage, or possibly a moulded gutta-percha splint. Union takes place very rapidly and necrosis is seldom met with.

With regard to the malar bone and zygoma, it probably will be impossible to manipulate the fragments into position or to elevate the zygomatic arch. When this is so an incision will be necessary under an anæsthetic, and the bone fragments should be elevated into position with a bone elevator through an external incision on the cheek.

Dislocation of the Lower Jaw (Temporo-mandibular Joint). This is a common injury which, as a rule, is produced by the pull of the muscles acting upon the jaw when it is opened. It may be unilateral or bilateral, the latter condition being the more common, and usually being seen in middle-aged females. The accident is most likely to happen when yawning or laughing, but it also has occurred as the result of blows on the chin, when biting hard substances, or by the introduction of a gag or other appliance into the mouth of an anæsthetised patient. These latter varieties are usually unilateral. In all of these conditions the condyle, accompanied by the meniscus, slips forwards out of the glenoid cavity on to the articular eminence, this being up to a certain point a natural movement; but when the condyle is in this position, should the pterygoid muscles contract violently, they will pull it over the articular eminence so that it comes to lie under the zygoma, and when here it is firmly fixed by spasm of the muscles of mastication.

Patients are occasionally seen with a lax joint, in whom a recurrent dislocation repeatedly occurs with little or no provocation.

Clinically it is found that the appearance is characteristic; the mouth is held widely open with the lower jaw projecting, and the chin prominent, and fixed in this position. Speech and swallowing are interfered with and the saliva may run out of the mouth. The condyle is usually palpable in its unusual situation, and behind the projection to which it gives rise an abnormal hollow can be detected just in front of the tragus of the ear. In some cases the displaced coronoid process may be felt from inside the mouth and below the zygomatic bone.

If the dislocation is unilateral the deformity and all the signs and symptoms are less marked and a certain degree of movement remains. The chin and jaw, however, will be displaced noticeably towards the opposite side.

Very rarely a posterior dislocation of this joint has been described associated with a fracture of the tympanic plate, the condyle passing upwards and into the skull.

Treatment. Reduction must be performed, and this is as a rule easy. The patient sits on a chair with the surgeon facing him, his head being supported from behind by another person. The surgeon protects his thumbs by a roll of lint or gauze, places both thumbs in the mouth on the back molars, and presses downwards and backwards to disengage the condyle from in front of the eminentia articularis, and overcome the spasm of the muscles of mastication. Once this has been done the muscles usually will pull the condyle into its correct position with a distinct snap, while if it will not go back the whole jaw and chin can be pushed backwards. If this cannot be accomplished, a cork should be placed between the molar teeth on each side, and with this as fulcrum the point of the chin should be lifted up and pushed back. An anæsthetic is not as a rule necessary. After reduction a four-tailed bandage should be applied for five or six days, and the patient must not be allowed to open the mouth widely for some weeks

Unreduced Dislocations. Unreduced dislocations are sometimes seen, usually as the result of the condition not having been diagnosed. After the condition has been present for some time a certain amount of movement is regained and the patient can eat, talk and swallow up to a certain point, but the deformity remains and should render the condition obvious. The question of reduction will arise, and it is highly unlikely that this will be accomplished if the condition has been present for more than eight weeks. Several attempts may be made, and if these fail operation will have to be performed. This will be a difficult procedure, owing to the spasm and shortening of the muscles, and tenotomy of the masseter and pterygoid muscles or removal of the meniscus may be necessary. When this is done it may be possible to reduce the condyle. If this cannot be accomplished, the condyle had better be removed to increase the mobility of the jaw.

Internal Derangement of the Temporo-mandibular Joint. This intra-articular cartilage is liable to the same displacements as occur in the knee joint. It may become displaced by the action of the internal pterygoid muscle, and will then become nipped during the closing of the mouth, giving rise to severe pain and partial locking of the jaw, so that the two jaws on the affected side cannot be brought into apposition and complete mastication is impossible. The joint is acutely tender to the touch, and after a few hours swelling will occur in front of the ear from effusion. It is usually possible to reduce the cartilage by opening the mouth widely, pressing upon the joint and slowly closing the mouth. If, however, this cannot be done the cartilage should be excised by open operation.

Clicking Jaw. This condition, in which the opening and closing of the mouth is accompanied by a sharp snap often audible at some distance from the patient, is due in most cases to a subluxation of the meniscus. Rarely, however, reflex irritation from an unerupted wisdom tooth, or in older people the presence of osteoarthritic changes in the jaw, may give rise to it. It may be very difficult to determine on which side the click is.

Treatment consists in removal of the cause. This often means removal of the cartilage.

Diseases of the Temporo-mandibular Joint. These are discussed in Vol. I., Ch. XX.

CHAPTER V

THE TONGUE AND SALIVARY GLANDS

Surgical Anatomy. The tongue is developed in two separate portions, which arise from different branchial arches. The front or buccal part, which is in front of the foramen cæcum and the V-shaped line, develops from the tuberculum impar which sprouts from the first arch and the first cleft, while the back or pharyngeal portion behind the foramen cæcum is derived from the ventral ends of the second and third arches. The foramen cæcum is regarded as the relic which marks the spot from which the thyroglossal duct originally budded out.

The bulk of the tongue is formed of a mass of interlaced striped muscle fibres, comprising both the intrinsic and extrinsic muscles, and consists of two lateral halves separated from each other by a median fibrous septum. There is no communication between the blood and the lymph vessels of the two sides of the tongue through this septum except near the tip. The tongue is covered by squamous epithelium, and is attached to the hyoid bone and mandible by the hyoglossus and geniohyoglossus muscles.

The buccal part of the tongue has on its surface two kinds of papillæ, while the V-shaped line which separates it from the pharyngeal part is occupied by the large circumvallate papillæ, which are thought not infrequently by nervous patients to be a cancer of the tongue. Underneath, the tongue is fixed to the floor of the mouth and the back of the mandible by a fold of mucous membrane known as the frænum, while the mucous membrane under the tongue contains specially large mucous glands.

The pharyngeal part of the tongue dips down in front of the epiglottis and is attached to the hyoid bone. It has no papillæ on its surface, but contains much scattered lymphoid tissue sometimes known as the lingual tonsil.

The lymphatic drainage of the tongue is of the greatest importance. The anterior third of the tongue drains its lymphatic vessels into the subhyoid and submaxillary glands, and it is in this portion of the tongue, near its tip alone, that some crossing of the lymphatic vessels from one side to the other occurs. The middle third of the tongue drains directly into the submaxillary glands and into some of the upper deep cervical glands upon the jugular vein. The posterior third of the tongue and its base drain directly into the deep cervical glands, and there is one of these glands especially, lying near the bifurcation of the carotid, which is frequently one of the first to be involved in carcinoma of the tongue.

The lingual artery supplies the greater part of the tongue with its blood. This, after leaving the external carotid, passes up into the tongue behind the hyoglossus muscle and then runs forwards to the tip of the organ just to one side of the median septum and near the under surface of the organ.

The nerve supply of the tongue is derived from several different sources. All the musculature is supplied by the hypoglossal nerve, which is a purely motor nerve. The glosso-pharyngeal supplies the posterior third of the tongue and the lingual branch of the fifth nerve supplies the anterior two-thirds with ordinary sensation, both these nerves being sensory nerves. The sense of taste is probably conveyed by the glosso-pharyngeal from the posterior third and by the chorda tympani which joins the lingual nerve, from the anterior two-thirds of the organ.

Under the tongue, in the front part of the floor of the mouth, are many large mucous glands, one group of specially large glands near the front part of the tongue being known as the glands of Blandin and Nühn, while in this situation, on either side of the frænum, the opening of the duct of the submaxillary gland (Wharton's duct) and the ducts of the sublingual glands (ducts of Rivinus) will be found.

The tongue and mouth always should be inspected in a good light (artificial if necessary) and with a spatula. The movement and power of protrusion should be tested carefully, while careful palpation will reveal the presence of induration, swellings or hard patches.

Congenital Affections. Several minor congenital conditions of the tongue are seen, but they are all rare.

(*a*) Complete absence of the tongue or lack of development of one-half of the organ have both been described: hemiatrophy of the tongue may be congenital or due to paralysis of the hypoglossal nerve.

(*b*) Babies are often brought up by their mothers with the complaint that they are suffering from *tongue-tie*, and there is a popular superstition that it may interfere with their talking; frequently the parents will blame this condition if the child is slow in learning to speak, or lisps. On examination it is usually found that the frænum is shorter than usual, whereby the tip of the tongue appears to be tied down to the floor of the mouth, so that it cannot be protruded; but it should be remembered that in all babies the frænum is always short. Some children with this condition find sucking difficult, but there is no evidence that it interferes with speech, and it is doubtful whether the condition is really pathological at all.

The *treatment* is simple, and the parents as a rule will not be content until it is adopted. The tip of the tongue should be held up by the fingers and the stretched frænum snipped across with a pair of scissors, the incision being carried back until the tongue appears to be free: on no account must the frænum be divided completely, or the tongue may fall right back (see below).

(*c*) In other cases the tongue appears to be tied down to the floor of the mouth at the sides by folds of mucous membrane, this condition being known as *ankylo-glossia*. Apart from the congenital cases, which are usually slight, this sometimes occurs as the result of scarring following ulceration or operations. The condition can be put right by means of a little plastic operation.

(*d*) An excessively long frænum is occasionally encountered, and this is sometimes combined with an extra length of tongue. Some of these children can put their tongue back behind the soft palate, while cases have occurred where, as the result of this condition, the tongue has fallen back into the pharynx and caused fatal suffocation. After operations where any disturbance has been caused to the frænum or front of the floor of the mouth this condition should be guarded against. Should the frænum appear to be too long, it can be shortened easily and tightened by a plastic operation.

(*e*) Very rarely the tongue is bifid, the cleft usually being only partial, and passing back for about an inch into the substance of the organ. Associated with this there is sometimes a congenital cleft of the mandible and lower lip (see p. 156). This condition really requires no treatment, but should the patient complain of its appearance it can be remedied easily by paring and suturing the two halves of the organ.

(*f*) **Macroglossia.** This condition is due to several different causes. In the acquired forms it is due either to acromegaly or to previous gummatous ulceration followed by diffuse fibrosis. Most commonly it is a congenital condition due to lymphatic obstruction and dilatation, accompanied by a considerable secondary œdema and overgrowth of all the fibrous tissues. Recurrent attacks of inflammation in this case may lead to further increases in size, as in other cases of lymphangiomata. In other instances the condition is due to neuro-fibromatosis of the nerves of the tongue, to formation of angiomatous tissue or to actual overgrowth of the muscular tissue. This last form is seen in mentally deficient patients, and is often accompanied by hemiatrophy of the face; it is not progressive. In these conditions the tongue becomes enlarged in all directions, is indented by the teeth and protrudes from the mouth, the whole tongue being affected as a rule. Ulceration and congestion are liable to occur later on, with the result that the tongue becomes purplish and dry in appearance, while in the lymphangiomatous forms lymphatic vesicles may appear all over its surface. The enlargement may be continually progressive, or in other cases it may become stationary; in severe cases the teeth are forced outwards and cause ulceration of the tongue, while the jaws are deformed. The repeated attacks of inflammation to which the lymphangiomatous form is liable are probably due to the rupture of lymphatic vesicles, permitting septic infection to occur. Ulceration and hæmorrhage may be severe, while in other cases a sarcoma has ultimately supervened.

The *treatment* is simple. A large V-shaped portion should be excised from the front of the tongue and the two halves of the organ sutured together in the case of lymphangiomatous or muscular enlargement. In the nævoid form it is also best excised, though other methods of treatment of nævus may be tried (see Vol. I., Ch. VIII.).

Lingua Plicata (Geographical Tongue). This condition is seen in children either as a congenital variation or associated with and the result of some form of macroglossia. The epithelium of the tongue is thickened and the organ is criss-crossed by large, deep folds which cut it up into flat areas like those seen in a map of the world. Food and debris collect in these folds, become infected, and give rise to troublesome glossitis. The condition is best treated by painting the tongue with iodine or permanganate of potash.

Wounds and Injuries. These are usually caused either by the teeth in children who have falls, and in epileptics, or else as the result of foreign bodies, such as pipes, sharp things held in the teeth or displaced teeth being driven into the tongue. Such foreign bodies sometimes become buried in the substance of the organ. Hæmorrhage is often severe, especially if the back of the tongue is wounded, while secondary infection and secondary hæmorrhage are serious, though fortunately infrequent, complications. Chronic ulcer due to injury from a sharp tooth is described on p. 196.

Treatment. The mouth should be washed out with an antiseptic wash and any foreign body removed, for it must not be forgotten that small foreign bodies sometimes will remain embedded in the tongue for many years. In most cases the bleeding can be arrested by catgut stitches, by which the lacerated tissues can be drawn together firmly, but sometimes the bleeding point will need picking up and tying. Severe bleeding from the tongue always can be stopped temporarily by pulling the tongue forcibly forwards out of the mouth, as this will compress the vessels. In some severe cases, and often in secondary hæmorrhage, the lingual or external carotid arteries may need tying. Owing to the vascularity of the organ its healing powers are good, and portions of it which are almost completely detached often will heal and unite if properly sutured into place.

Inflammatory Conditions of the Tongue. The inflammatory conditions of the tongue may be grouped under four headings: acute superficial glossitis, acute parenchymatous glossitis, chronic superficial glossitis, and chronic parenchymatous glossitis. Tender, enlarged papillæ are often seen at the back of the tongue, and are best removed under a local anæsthetic.

Acute Superficial Glossitis. This consists in an acute catarrhal inflammation with the formation of shallow ulcers, which occurs in association with a general stomatitis (see p. 168).

Acute Parenchymatous Glossitis. This is an acute septic inflammation of the connective tissues and muscles of the tongue. It is usually due to streptococci which may be introduced by infected wounds, or by the bites and stings of insects, while in other cases the condition occurs in the course of acute fevers or in the form of a *mercurial glossitis* which accompanies the stomatitis that is due to overdosage with mercury. A diffuse, acutely painful, œdematous swelling of the whole organ occurs, the whole tongue rapidly enlarging, a ropy saliva is secreted and poured out, swallowing is difficult, while the œdema may extend to the glottis and epiglottic folds and give rise to suffocation. Sometimes, when due to a local cause, the condition remains confined to one half of the tongue. The condition, whatever its cause, is made worse by alcoholism or poor health, but even in these conditions it does not as a rule go on to suppuration; should it do so, a lingual or sublingual abscess will be formed. There is usually high fever, malaise and enlargement of the cervical glands, which in severe cases may give rise to spreading cellulitis of the neck and to fatal mediastinitis. A similar and more severe form of the condition is sometimes seen as the result of contraction of "foot and mouth disease" from cattle. Here the tongue becomes œdematous and swells, while vesicles which burst and ulcerate form on the mucous membrane. Gangrene of a portion of the tongue sometimes sets in, and death from œdema of the glottis or spreading cellulitis of the neck is not uncommon.

FIG. 67. Epithelioma of the upper lip and leukoplakia of the tongue in a man of fifty-five.

Treatment. This consists in removing any cause that may be discoverable and giving saline purgatives and chlorate of potash by the mouth, while antiseptic mouth washes should be employed. Leeches beneath the angle of the jaw will give relief, while in cases where the swelling is very severe a free incision should be made on the back of the tongue on either side of the middle line to let out fluid and reduce œdema; sulphanilamide and antistreptococcic serum should be employed. In cases where asphyxia is becoming marked a tracheotomy or laryngotomy will be required, and this should not be left until too late. If the infection is spreading into the neck, incisions will have to be made here also and the condition treated in the same way as Ludwig's angina (see p. 399).

Abscess in the Tongue occasionally occurs as the result of a subacute form of the preceding condition, while sometimes it is more chronic and arises spontaneously owing to infection of the deeper tissues of the tongue by means of organisms which have got in through an abrasion on its surface, such as an accidental bite. It gives rise to tender, fluctuating swelling deep in the substance of the tongue. Free incision soon will cure the condition, and this should be made wherever the swelling appears to be nearest to the surface. In many instances this will have to be done from the midline of the neck.

Chronic Superficial Glossitis. This is a common and serious complaint, and consists of a chronic inflammation of the mucous membrane of the tongue, often accompanied by a similar condition affecting the mucous membranes of the cheeks and lips. Though there is no doubt that the majority of cases are due to tertiary syphilis, yet septic teeth, excessive smoking, over-indulgence in hot and spicy foods or in neat spirits, assisted perhaps by chronic dyspepsia and gout, undoubtedly have an important effect in making the condition worse, and in some cases it is possible that one or other of these conditions is the only cause. The disease can be divided into several different stages, which are not, however, separate from one another, but are usually coincident, and one part of the tongue usually will be in one stage, while another part will be in a more advanced condition. The disease is usually seen in patients between forty and sixty, most commonly in men, and is very intractable, while it is exceedingly likely in the end to give rise to epithelioma. It must be regarded as a persistent chronic inflammation of the deeper layers of the epidermis and of the subepidermal tissues, associated with much proliferation. The stages of the disease are roughly as follows :—

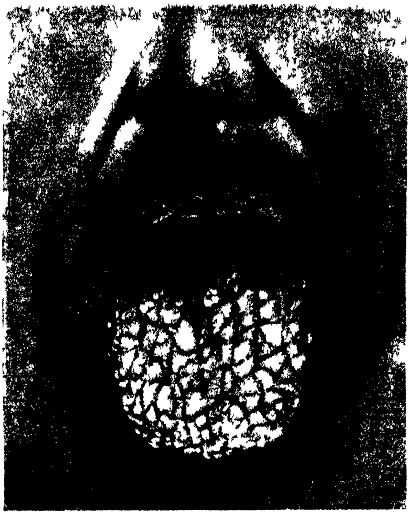


FIG 68. Severe leukoplakia of the tongue

(*a*) The deeper parts of the epithelium become inflamed, infiltrated with round cells and mild fibrosis, with the result that the papillæ become swollen and the surface of the tongue becomes red and hyperæmic in patches, which gradually may coalesce and fuse together.

(*b*) After a time overgrowth and cornification of the surface of the epithelium appears so that it becomes thick, opaque, hard and raised above the surface, giving rise to raised, white, hard plaques, replacing the previous red patches. The patches are square or oblong-shaped, and also tend to coalesce. This stage is known as **leukoplakia** or **leukokeratosis**, and it may convert large portions of the surface of the tongue into a firm, white, hard surface. This condition also has been called psoriasis and ichthyosis of the tongue.

(*c*) After this the blood supply is not sufficient to preserve the vitality of all this overgrown epithelium, so that the epithelial layers are shed, leaving behind smooth, red, raw patches without any papillæ, those portions of the tongue from which the epithelium has departed having a raw glazed appearance. A very characteristic stage of the disease commonly seen consists in a tongue which is raw, red, dry and glazed at some points, while in other parts it is covered by the white leukoplakic streaks.

(*d*) After this has occurred, as the result of the atrophic condition of the mucous membrane, ulcers, cracks and fissures will appear on the surface of the organ, often with one median fissure and others branching out from it. The cracks may be quite deep, and are due to the contraction of newly formed fibrous tissue in the deeper layers. (The precancerous stage.)

(*e*) At a later date in these cracks and fissures it is highly likely that an epithelioma will appear. The onset of this condition probably will be shown by an increase of hardness around the fissure, combined with the appearance of red, raised, sprouting granulations. Such an epithelioma is sometimes of comparatively slow growth.

The different stages of the disease probably will be seen concurrently, while in all stages the patient complains of great discomfort, the tongue being dry and hard, and sometimes exceedingly tender, especially when irritated by hot, spicy or stimulating food. There is impairment of speech, deficiency of the sense of taste, and persistent thirst, while the glands below the jaw may become enlarged. The disease is very intractable and resistant to treatment, while it exhibits a considerable tendency to recur after apparent cure. An important feature of the disease is the fact that, in spite of the removal of all possible causes, such as septic teeth, smoking, active syphilis, etc., the condition still persists, and even may progress.

Treatment. All sources of irritation in the mouth must be removed ; in particular, smoking, tobacco chewing, spirit drinking and the taking of acid wines, port wine, hot, spicy or irritating foods, must be abolished ; all septic teeth should be removed, and the mouth kept clean by carefully cleaning the teeth and the employment of antiseptic mouth washes, which must not be irritating. An alkaline lotion after meals should be employed to remove all debris of food. Antiseptic ointments may be employed when going to bed, while cracks, fissures and warts may be touched with chromic acid (5 grains to the ounce) or 20 per cent. lactic acid. Strong caustics should on no account be employed, as they may precipitate an epithelioma, and in many cases it is wise to excise the cracks and fissures, as in this way only can the probability of epithelioma be avoided. As the condition is frequently syphilitic, an efficient course of antisyphilitic treatment should be given, but the results of this are often disappointing. Intravenous arsenic is the most promising. Radium has recently been employed with considerable success in this condition. Once the condition appears to be epitheliomatous it must be treated as described on p. 204, while in very intractable cases it is both justifiable and wise to remove a large part of the tongue to prevent the malignant change supervening.

Smokers' Patch. This consists of a small round area on the front of the tongue from which the papillæ have disappeared, and which is raised, congested and smooth, and often covered by a whitish crust. It thus resembles the first and second stages of the foregoing condition. The condition is painless, but if the crust is removed a raw, tender surface is left, while if smoking is persisted in it will spread eventually over a considerable area of the tongue and take on the characteristics of the above condition.

Its *treatment* consists in stopping all smoking, painting the patches with tannic acid or alum, and using a potassium chlorate mouth wash.

Sublingual Abscess. A sublingual abscess occurs in the floor of the mouth under the tongue. It is usually acute, and is either the result of a preceding parenchymatous glossitis or is due to infection of the sublingual salivary gland or to an injury to the oral mucous membrane, as by some sharp particle in the food. An acutely tender, painful, puffy swelling forms in the floor of the mouth, which pushes the tongue upwards, while after a time the tongue itself becomes swollen and œdematous; the infection is liable to spread into the submental region and there give rise to a spreading cellulitis of the neck. There is high fever and malaise, whilst œdema of the larynx is liable to set in. A large sublingual abscess occasionally forms further away from the floor of the mouth as the result of Ludwig's angina.

The abscess should be opened as soon as possible by an incision either through the mucous membrane of the floor of the mouth or through the skin under the chin according to which structure it appears to be nearest to.

Ulcers of the Tongue. These are due to many different causes.

(*a*) **Dental** or **Traumatic Ulcers.** These are the result of the irritation of a sharp tooth or tooth-plate, and are seen, therefore, at the borders of the tongue and opposite a sharp tooth. The condition commences as a swollen excoriated patch, which soon gives rise to a painful superficial ulcer, while after a time, if the tooth is not removed, the ulcer becomes deeper and crater-like, with firm, indurated edges. It will then resemble an epithelioma, except that there are no signs of sprouting granulations and the edge is not raised and everted; it must be remembered that such an ulcer is an exceedingly dangerous condition in that it is highly likely to become epitheliomatous, but the fact that it is hard and indurated is not necessarily proof that this has occurred. The offending tooth or tooth-plate should be removed at once, and if the ulcer does not heal promptly, it should be excised with a small portion of the tissues round it and submitted to microscopy.

(*b*) **Dyspeptic Ulcers.** These are small, shallow, white ulcers, very painful, usually on the dorsum of the tongue near its tip, and associated with gastro-intestinal upsets. They should be touched with silver nitrate and the gastro-intestinal function treated. In some instances a curious red, patchy, wandering rash is seen over the tongue (known as a geographical rash from its patchy appearance). This is usually due to a combination of dyspepsia and oral sepsis.

(*c*) **Tuberculous Ulcers.** Tuberculosis does not occur primarily in the tongue, but is usually a secondary infection in adults who are suffering from laryngeal tuberculosis or advanced phthisis owing to the bacilli present in the sputum, which infect the surface of the tongue through some abrasion. The process usually commences in the form of a small submucous swelling, painless and near the side or tip of the tongue. Caseation occurs in the swelling, which bursts, and an ulcer is formed. The typical tuberculous ulcer results; it is a shallow, very painful ulcer, nearly always at the side or tip of the tongue, often multiple, with an uneven, pale, flabby, bluish, streaky, undermined edge, no induration around it, and its base covered with feeble granulations giving rise to a watery discharge. Frequently small tubercles will be seen to be scattered around it. A deeper form of ulceration is sometimes seen near the tip of the tongue, which gives an appearance as though the tip of the tongue had been cut away with a knife. The submaxillary glands sometimes become infected, salivation is profuse, and the pain severe enough to interfere greatly with speaking or eating.

Treatment. Unless the phthisis is very advanced the condition should be treated by painting the ulcer with cocaine, excising it completely, touching the raw tissues with carbolic acid, and putting in a catgut stitch. If the phthisis is too advanced and only palliative treatment can be adopted, the pain may be relieved by dusting the ulcer with orthoform or painting it with cocaine before meals.

(*d*) **Lupus.** This attacks the tongue rarely, and when it does so, it will be found to have spread there from the face, nose or cheeks. The progress is slow and the condition is usually seen as a slowly spreading granulating surface with a tendency to heal at its centre; the characteristic apple jelly nodules are not seen here. The condition should be treated by X-rays or radium, while if it is small and localised it should be excised.

(*e*) **Frænal Ulcers.** These occur on the frænum in children with whooping cough. They disappear when the disease is cured.

(*f*) **Herpetic Ulcers.** Herpes occurs on the tongue (and also on the cheeks), and is usually confined to one-half of it in the form of multiple, small vesicles or pustules which break and give rise to shallow irritating ulcers. Mild antiseptic washes should be applied, and the condition soon will be cured, though it frequently recurs two or three times.

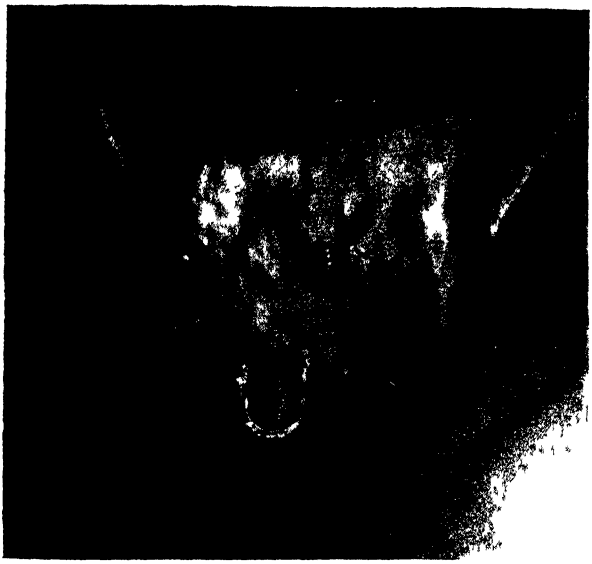


FIG. 69 Gummatous ulcer of tongue with surrounding superficial glossitis.

(*g*) **Mercurial Ulcers.** These are seen in mercurial glossitis (see pp. 170 and 193)

(*h*) **Syphilitic Ulcers.** These may be primary, secondary or tertiary, and are described below.

(*i*) **Epitheliomatous Ulcers** (see p. 201).

Syphilitic Disease of the Tongue.

(*a*) **Primary Chancre.** This occurs on the tongue as an indolent, hard, superficial sore usually near the tip, sometimes œdematous, but usually unaccompanied by much infiltration. After a time it ulcerates and runs a similar course to any other extragenital chancre. It is most common in men. There is a marked amount of enlargement of the submaxillary glands, and usually the submental ones as well.

(*b*) **Secondary Lesions** are common on the tongue. Mucous patches, shallow snail-track ulcers and cracks and fissures are all seen. Occasionally a condyloma which is sessile, firm and wart-like, occurs on the dorsum of the tongue, and has sometimes been called Hutchinson's wart. These secondary lesions occur especially at the sides and back of the tongue and on the fauces also.

(*c*) **Tertiary Lesions.** The most common tertiary lesions are gummata and chronic superficial glossitis, already described on p. 194.

Chronic Parenchymatous Glossitis (Diffuse Gummatous Glossitis) is a tertiary syphilitic condition in which the substance of the muscle of the tongue becomes infiltrated with an abundant formation of granulation tissue, leading to a diffuse infiltration of the whole organ with fibrous tissue, so that it becomes firm, shrunken and hard, while its mucous membrane becomes covered with rounded bossy swellings, painless, elastic, and of a dull red colour. It may be regarded as a diffuse gummatous infiltration of the whole organ. Ulceration does not usually occur, and the condition reacts to treatment well. A somewhat similar condition is sometimes seen as the result of oral sepsis.

Localised Gumma of the Tongue is fairly common, and sometimes occurs superficially immediately under the mucous membrane, in other cases being more deeply placed in the muscle of the tongue. It is usually seen as a late tertiary phenomenon in patients of either sex aged about forty, and most commonly will be found on the dorsum of the tongue, nearer its centre than its edges, where it gives rise to a globular, tough, elastic, painless swelling, increasing in size rapidly and later becoming soft and fluctuating, when it will resemble a cold abscess ; after a time the mucous membrane will give way and characteristic contents will be discharged, giving rise to a typical gummatous ulcer (see below). The condition is painless, may be multiple, and does not interfere with the protrusion of the tongue, while the cervical glands do not become enlarged. The mucous membrane over the swelling is raised into a rounded red boss, often loses its papillæ and becomes smooth, and ultimately necroses and gives rise to the next condition.

Gummatous Ulcer of the Tongue. This is a common lesion resulting from the breaking down of the foregoing condition, and consists of a deeply excavated, sharply cut round or oval ulcer with a yellow slough at its base. The edges are ragged, hyperæmic and undermined, not raised, rolled or everted, and the surrounding tissues thickened and indurated for a short distance only. Protrusion, deglutition and articulation are very little affected, while the cervical glands are not enlarged unless the condition becomes septic, and there should be a clear history that the ulcer commenced with a solid swelling which burst. The ulcer is remarkably painless and chronic, with little tendency to give rise to sprouting granulations unless an epitheliomatous change supervenes upon it, which is by no means uncommon. The lesion heals readily under antisyphilitic treatment and leaves a permanent puckered cicatrix, and the tongue may be extensively scarred and deformed.

Syphilitic fissures are due to a similar cause, and appear as deep clefts or cracks in the substance of the tongue, either long and narrow or else stellate. It must be remembered that gummatous ulcers closely resemble epithelioma of the tongue, while the presence of a positive Wassermann is of little assistance in the differential diagnosis, as this reaction is nearly always positive in epithelioma also (see p. 201).

Treatment. General antisyphilitic treatment should be given, and the lesions, with the exception of chronic superficial glossitis, will clear up rapidly. In addition to this, the mouth must be kept as clean as possible by the use of chlorate of potash or other mouth washes, while powdered iodoform and borax or mercurial ointment may be placed in the depths of the ulcer.

Papillitis. This is an overgrowth of the papillæ (especially those at the side of the tongue), which become swollen, red and very tender, usually as the result of oral sepsis. They should be touched with a crystal of chromic acid.

Actinomycosis. This is sometimes seen in the tongue, either alone or in association with a similar infection of the jaw. It commences as a hard, slow-growing infiltrated mass on the tongue ; it runs the course of actinomycosis elsewhere and breaks down to form multiple fistulæ. If possible, it should be completely excised.

Black Hairy Tongue (Melanoglossia, Nigrities). This is a rare condition due to overgrowth of the filiform papillæ, and usually is confined to the centre of the dorsum of the tongue. The long, wet papillæ are usually stained black, either by bacterial action or by chemical changes in certain food substances, and give an appearance closely resembling matted wet black hair. The condition is absolutely symptomless. A specific organism producing the black stain—an oösporon—has been described, but this is quite unproved. The condition may be associated with dyspepsia or oral sepsis.

The treatment consists in removing oral sepsis, etc., gently scraping away all the black papillæ with a blunt instrument, and providing a weak salicylic acid paint for the tongue and a mouth wash.

Dermoid and other Cysts. Dermoid cysts are met with in the midline, deep in the substance of the tongue or underneath it. They lie above the mylohyoid muscles and appear usually in early life or in adolescence. Most commonly the cyst is found projecting under the chin, though sometimes it will bulge into the mouth and can be palpated between two fingers, one inside and the other outside the mouth, and felt to consist of a smooth, round fluctuating swelling, strictly in the midline, and sometimes showing a yellowish colour through the mucous membrane. Though in some cases these are sequestration-dermoids due to inclusion of epidermal elements in the midline fusion, in other cases they certainly should be regarded as tubulo-dermoids due to persistence of the thyroglossal duct. These tumours are easily removed and not as a rule adherent. They should be dissected out by an incision under the chin, and not from within the mouth.

Thyroglossal Tumours (Lingual Thyroid). Solid round tumours consisting of normal thyroid tissue may develop anywhere in the embryonic thyroglossal tract. They are most commonly seen on the dorsum of the tongue, near the foramen cæcum, and extend down in its substance towards the epiglottis, where they appear as painless round elastic tumours, growing slowly till they reach a considerable size, and of a dark red or purple colour. Cystic degeneration may occur within them, and hæmorrhages into these cysts will give rise occasionally to rapid increase in the size of the tumour, which sometimes will cause grave difficulty in swallowing, speech and respiration. The variation in the size of the tumour thus produced is often of diagnostic help (see p. 400). It must be remembered that when these tumours are present there may be no thyroid gland lower down in the neck.

Treatment. No treatment is required unless the swelling is producing symptoms. If this is so, it should be dissected out.

NEW GROWTHS OF THE TONGUE

Innocent Tumours. Innocent tumours are not common on the tongue. The commonest variety is the **papilloma,** which may occur anywhere on the surface of the tongue, and at any age, and gives rise to a firm white papilliferous tumour, either sessile or pedunculated, painless, without the least infiltration or induration round it, with little tendency to bleed, and causing no glandular enlargement. It often appears to arise from an enlarged fungiform papilla ; it is liable to become malignant, and therefore should be removed by excising it together with a small wedge-shaped portion of the tongue. This can be done easily under a local anæsthetic.

The other innocent tumours seen on the tongue are the *angioma*, which is seen in children as a brightly coloured, red, vascular tumour of slow growth liable to give rise to severe hæmorrhage, and sometimes very large: this should be excised if possible—if not, electrolysis and diathermy should be used; *endothelioma* and *adenoma*, which occur as superficial pinkish nodular tumours on the surface of the tongue; *fibroma*, which starts under the mucous membrane as a pale, hard, pedunculated swelling; and, very rarely, a *lipoma*, which is a soft rounded swelling deep in the substance of the tongue, or a *plexiform neuroma*.

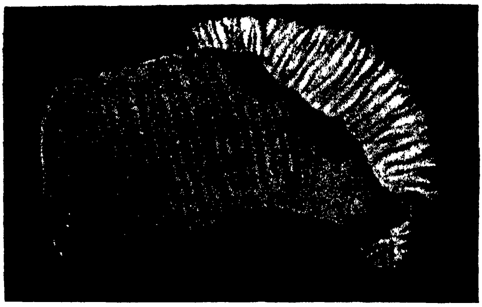


FIG. 70 Papilloma of the tongue. The benign nature of the growth is shown by its sharp line of limitation and the total absence of any infiltration of the muscular tissues.

Malignant Tumours. These occur in two forms, *carcinoma*, which is an exceedingly common and fatal form of the disease, described on p. 201, and

Sarcoma. This is rare, but is occasionally seen in children as a round-celled muscular fibro-sarcoma, starting deep in the tongue and giving rise to a firm, rounded, elastic swelling, usually growing rapidly and soon ulcerating and fungating. The pain is slight in the early stages, but becomes marked later on. The condition will resemble a gumma closely, and the diagnosis is usually uncertain until a portion has been removed and examined microscopically. The glands of the neck are not usually involved, but the condition gives rise to metastases elsewhere in the body, though it varies greatly in malignancy. The treatment is the same as that of carcinoma, the prognosis

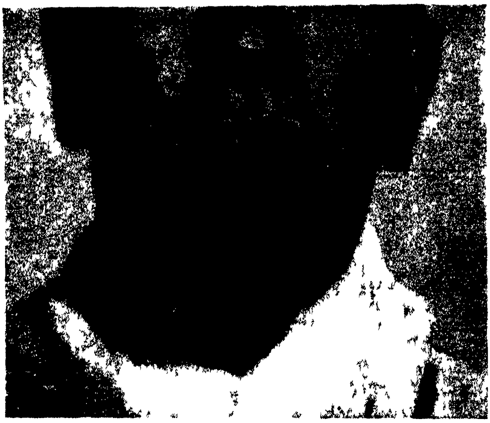


FIG 71. Fungating sarcoma of the tongue in a man of fifty.

being equally bad, though delayed recurrences are less likely. If it is not considered to be suitable for operation, radium is quite likely to be beneficial.

A pedunculated sarcomatous growth is sometimes seen growing from the surface of the tongue, while in other instances the tongue becomes invaded by a lymphosarcoma starting in or near the tonsil.

CANCER OF THE TONGUE

This is a very common form of squamous epithelioma, met with more often in men than in women, in the proportion of twenty-five to one, and usually between the ages of forty and sixty. There is no doubt that several precancerous conditions are present in the tongue which frequently lead to this disease. Superficial lesions in the form of chronic superficial glossitis are common, as also is the irritation of a sharp tooth or tooth-plate, and long-continued irritation due to smoking, especially the use of a hot, short clay pipe. The chewing of tobacco and of betel nut (in India) are also predisposing causes. Filthy septic teeth are present in every case, so much so that there is probably some causative connection ; while in other instances the disease appears to have been caused by too frequent application of strong caustics to chronic inflammatory and other lesions on the tongue. The malignancy varies considerably ; at the same time it must be regarded as a particularly malignant form of squamous epithelioma, this possibly being due to the sepsis which is nearly always associated with it. In over 80 per cent. of cases the Wassermann reaction is positive. The disease most commonly occurs in the front half of the tongue, usually nearer the edge than the midline, because of the presence of the teeth, while a not infrequent situation is under the front of the tongue in the neighbourhood of the frænum. Although in all cases ulceration sets in early, the disease presents several different clinical forms, and rapid involvement of the lymphatic glands occurs.

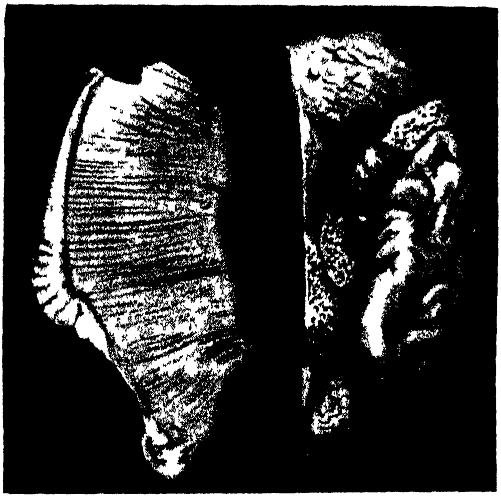


FIG. 72. *A simple papilloma and an epithelioma occurring on opposite sides of the same tongue.*

Clinical Features. The forms in which the disease appears are as follows :—

(*a*) Most commonly it appears as a hard, craggy, deep ulcer with a base covered with red granulations, extensive induration of the tissues round, and a raised nodular, everted edge. This form is most commonly seen round the edge of the tongue or underneath it.

(*b*) It sometimes appears as a hard, infiltrated, nodular wart. This is especially seen in association with leukoplakia. The base of the wart becomes infiltrated for a considerable area, and the muscular substance invaded, while ulceration will occur soon.

(*c*) It is often seen as a large, sprouting, papilliferous mass of firm, hard, red, raised granulations. This form is most commonly seen on the dorsum of the tongue.

(*d*) At other times it appears as a deep, hard crack or fissure, which is painful and surrounded by irritation.

(*e*) A rare form is one in which the whole substance of the tongue undergoes an extensive infiltration, causing it to become hard, puckered and shrunken, without any very extensive ulceration (wooden tongue).

(*f*) It sometimes spreads on to the tongue from surrounding parts, having commenced in the tonsil, fauces, gum or floor of the mouth.

Microscopically it will be found that in the early stages the infiltration of the surrounding tissues is due to small, round cells, chiefly in the subepithelial tissues, while there is an increased but irregular mitosis occurring in the epithelial cells. Later it will be seen that the interpapillary processes of epithelium are actively sprouting and growing downwards, first becoming club- or flask-shaped, and then branching in all directions. At the growing margin the irregular mitosis and keratin granules are seen, while at the central parts of the columns of growth the cells become flattened, keratinised, concentric in their arrangement, and form typical cell nests. These cell nests are often absent in very rapidly growing forms of epithelioma. The more mitosis there is and the fewer cell nests, the more malignant the growth is (and possibly the more sensitive it will be to radium). In advance of the epithelial growing edge, the round-celled infiltration can be seen spreading into the muscles and fibrous tissues; probably many of these round cells are cancerous.

However the growth starts, it soon gives rise to an ulcerating mass showing firm granulation tissue with a hard base, hard, raised, everted edges, and considerable infiltration of the depths of the tongue. The ulcer is covered with a grey, sloughy, foul surface, which bleeds readily, makes the breath fœtid, and may or may not be painful in the early stages. Protrusion of the tongue is difficult, and all movements of the tongue are limited and painful, this limitation of protrusion being especially marked when the growth spreads on to the floor of the mouth; the lack of movement will interfere considerably with articulation, mastication and swallowing. Irritation of branches of the trigeminal nerve will lead to profuse salivation, and the patient will allow the foul saliva to trickle out of his mouth owing to the difficulty in swallowing it. The pain soon becomes intense owing to involvement of the lingual nerve. It occurs at first in the tongue, but soon involves other branches of the fifth nerve, and is complained of largely in the ear and up the side of the head. As the disease spreads it may come to involve the gums and the jaws, the floor of the mouth, the epiglottis, the fauces or the tonsil.

The lymphatic glands rapidly become invaded. If the growth is near the tip of the tongue, the submaxillary glands are usually involved first; but certain lymphatic vessels run straight from the tip of the tongue to a few glands low down in the neck below the anterior belly of the omohyoid, and these must be examined carefully with the patient's collar off. If further back, the submaxillary glands will be the first to enlarge, while right at the back of the tongue the upper deep cervical glands (subparotid) will be first invaded. Soon the disease spreads to all the deep cervical glands down the main vessels, a particular gland near the bifurcation of the carotid being especially liable to early involvement (the principal gland of the tongue). In early cases a large percentage of the glandular enlargement is due to infection. If the growth is confined rigidly to one side of the tongue the glands probably will be confined to that side of the neck, unless the lesion is near the tip of the tongue or involves the floor of the mouth. But if the growth approaches the midline of the tongue and in the later stages, the glands on both sides are liable to involvement. These glands rapidly become enlarged, stony hard, and firmly attached to all the surrounding structures, especially the carotid artery and jugular vein. They may give rise to huge masses, and after a time these swellings undergo softening and will suppurate and burst, giving rise to huge fungating masses or ragged malignant ulcers. Metastases to other parts of the body, such as the liver or lungs, are very rare, while the patient, if untreated, usually dies within eighteen months from what may be regarded as one of the most unpleasant deaths conceivable. In the later stages a marked cachexia sets in due to a combination of pain, sleeplessness, starvation, and the absorption of septic products from the growth. Death, when it occurs, is due in the lucky cases to secondary hæmorrhages from the fungating masses in the neck, while in other instances it is the result of septic bronchopneumonia or the sheer exhaustion produced by the pain, starvation, and the foul, green, sloughing mass in the patient's mouth.

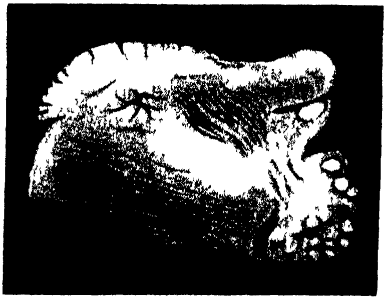


FIG. 73. Papilliferous epithelioma of the tongue, showing extensive infiltration of the muscular tissues.

Differential Diagnosis. Though in many cases the condition is obvious, it will be found not infrequently that it closely resembles syphilitic and other ulcers and papillomatous growths. This is especially so in the early cases, and this is the stage at which the surgeon hopes to encounter the disease if possible. Above all he should beware of the dental ulcer, which is especially liable insidiously to become malignant.

Gummata are not likely to resemble this disease until they break and form an ulcer, and it must be remembered that gummatous ulcers are often multiple, are usually situated on the dorsum, and not on the edge of the tongue, have sloughy, undermined edges, which are often serpiginous, are very little raised, and are not everted, while the surrounding tissues, though slightly infiltrated, are not indurated and hard, nor are the glands likely to be enlarged or protrusion of the tongue to be interfered with. These are points in which they do not resemble the carcinomatous ulcer. It must be remembered that little reliance can be placed upon the Wassermann reaction or the results of antisyphilitic treatment as an aid towards differential diagnosis. It also should be remembered that such conditions as dental, syphilitic and tuberculous ulcers, fissures, papilloma and leukoplakia may all undergo malignant change, in which case the two conditions may be present simultaneously. Tuberculous ulcers are not likely to resemble carcinoma, as they are shallow and soft, while simple ulcers and fissures heal quickly on the removal of their cause and give rise to little infiltration and no glandular involvement. The warty type of carcinoma may simulate closely a sessile papilloma, but in the latter cases there is no deep infiltration and induration. The features pointing strongly to malignancy are early involvement of glands, which are painless, hard and fixed, the infiltration and induration of the base of the ulcer and surrounding tissues, the fixity and interference with protrusion of the tongue. *If there is the least doubt about the condition a small portion of the edge of the ulcer or growth should be excised and examined microscopically.* If the microscopic section is indeterminate, the growth should be treated as a carcinoma.

Prophylaxis. There is no doubt that by attending properly to the teeth, curing oral sepsis, and avoiding the use of clay pipes and hot tobaccos much could be done to avoid carcinoma of the tongue. Old syphilitic lesions should receive adequate treatment, and all cracks, ulcers, fissures or warts be carefully attended to and excised, if they will not clear up, under a local anæsthetic and submitted to microscopy. If the microscopic report is that the condition is precancerous or " early epithelioma," it should be treated on the lines given below. Under no circumstances should repeated cauterisation be used on the tongue, as this is specially liable to induce a malignant change.

Treatment. The insertion of radium needles into the tongue around the growth causes it to disappear, at least temporarily, and of course preserves a mobile tongue, but, owing to the tendency to recurrence, probably the treatment which offers the best chance of a cure is free and complete removal, and for there to be any prospect of non-recurrence this must be done early in the disease. The essential features of the operation are that the growth, with a free margin of tongue surrounding it, must be removed ; it is always necessary to remove half the tongue, and frequently a good deal more. Moreover, whether radium or operation be used for the primary growth all the lymphatic glands and lymphatic vessels down the side of the neck must be cleared out, and to make this complete it is best to do it by means of a block dissection (see p. 208). The mouths of these patients are nearly always in a filthy state, and in most cases the first step will be to have all the teeth, or nearly all the teeth, removed and the mouth carefully washed out for some days with antiseptic mouth washes. Smoking is better stopped for a few days beforehand, and every effort is made to get the patient as fit as possible. These operations on the tongue, including the dissection of the glands, are serious operations, and it is better in many cases to do them in two stages. The question then arises as to which portion of the operation should be done first, the tongue or the glands. If the tongue is done first and a ten-day interval is allowed before the glands are dissected out, which would be the ideal proceeding, it is highly probable that the patient, especially a hospital patient, seeing that his tongue has been removed and the growth has gone, will refuse to have the second operation. On the other hand, if the glands are done first, during the ten-day interval between the two stages, all the lymphatic vessels leading from the tongue to the glands have been cut across, so that there is a considerable chance of carcinoma cells or septic organisms travelling down them into the loose cellular tissues of the neck from which the glands have been removed. We think it is wisest to do the tongue first, and then proceed with the operation on the glands as soon as possible, say, within five or ten days, but each case must be judged on its own merits, while in the case of certain methods of removing the tongue, to be described later, it is not possible to do the operation in two stages. If, as is not uncommon, it seems wise to remove the glands on both sides of the neck, the tongue and the glands on the side of the growth should be done at the first operation, and the glands on the other side at the second stage.

Before undertaking any operation on the tongue it is essential to teach the patient to feed himself with a rubber tube and cup, and to warn him that his speech will be indistinct for several days.

In all these operations for the removal of the tongue (of which five different methods are most commonly in use) it is of great advantage to have the anæsthetic administered by means of an intratracheal catheter. In this case there is no possibility of blood or foreign material getting down into the air passages, and thus there is no need for a preliminary tracheotomy, while the patient's head may be placed in that position which suits the surgeon best, independently of the anæsthetist. Efficient gags for keeping the mouth open will be required. The following are standard methods of removal of the tongue :—

(1) **Whitehead's Operation.** This consists in removing the tongue through the mouth by snipping it out with scissors, and by means of this operation the anterior two-thirds of the tongue can be removed on either one or both sides. It will be seen thus that this operation is suited for those cases where the growth is not very large and is on the tip or front half of the tongue. It is unsuitable for growths which extend back near the pillar of the fauces, or which extend on to the floor of the mouth and jaw, or which involve the under surface of the tongue. If the tip of the tongue only is involved, it may be removed by a deep V-shaped incision, while if the growth lies on the side of the tongue, does not approach the midline or extend very far back, it will be sufficient to use this method to remove the anterior two-thirds of one side of the tongue. In other cases the whole of the anterior two-thirds of the organ must be removed. If the glands in the neck are being removed previously it is wise, when doing this, to tie the lingual artery in the neck.

The mouth is gagged well open, the cheek retracted, silk stitches are passed through each half of the tongue, and it is drawn out by them ; the tongue is then divided by straight scissors down its midline or at whichever point on the side of it that it is decided to make the section ; it is drawn out of the mouth and the mucous membrane of the floor of the mouth is snipped with curved scissors close to its alveolar attachment and all round that portion of the tongue which is going to be removed. It is usually wise to set free and dissect up the sublingual salivary gland under the half of the tongue which is being excised, and to remove it with the tongue. The curved scissors are then passed in behind the symphysis and the geniohyoglossus snipped off from the bone. The tongue is then dragged right forward and is slowly snipped across at the posterior limit of the part to be removed, the anterior pillar of the fauces being divided if necessary, and while this is being done, if care is taken and a blunt dissector used, the lingual and dorsalis linguæ arteries can be seen and picked up before they are cut. The removal of the diseased portion of the tongue is then completed with the scissors and bleeding points are tied with catgut ; if preferred the diathermy knife can be used. The raw surface on the tongue is then obliterated as far as possible by drawing the tongue together with catgut stitches, and in most cases this raw area can be almost completely covered in by turning one half of the tongue back to meet the stump of the other half. If this cannot be done the mucous membrane of the dorsum can be stitched to that of the base of the tongue, while the free edge of the mucous membrane beneath the tongue should be stitched as far as possible on to the alveolar margin to prevent the organ falling back. If the whole tongue needs removal, it can be done by the above method without splitting it. The patient usually will recover rapidly from this operation, and is comparatively fit again within a week. A stitch should be left through the remaining portion of the tongue for some days in case there is any tendency for it to fall back.

Local Excision of Ulcers and Cracks. This should be done with the knife or scissors ; the incision should be V-shaped at the tip of the tongue or at the edges, and elliptical if the lesion is on the dorsum ; it should be deep enough to include a small portion of the muscle tissue. The wound should then be sutured with catgut.

(2) **Syme's Operation.** This operation, which, by means of splitting the lower jaw, gives a wonderful exposure of the lower surface of the tongue and the front of the floor of the mouth, is particularly suitable for growths which involve the floor of the mouth under the front of the tongue, the under surface of the tongue, and those which necessitate complete removal of the whole organ. It is also better than the preceding operation in cases where, from extensive infiltration, the tongue cannot be properly protruded or drawn out. A silk stitch is passed through the tip of the tongue and a vertical incision is made in the middle line of the lower lip, completely dividing the lower lip down to the bone and extending down into the midline of the submental space almost to the hyoid bone. Bleeding points are picked up, the soft tissues separated from the jaw for a small distance on either side, and two small holes drilled through the lower jaw at corresponding points just to one side of the midline. The mandible is then sawn through in a slightly oblique or angled direction and its two halves drawn as wide apart as possible by means of blunt hooks. This will be assisted by cutting or detaching some of the muscles behind the jaw. It is then possible to remove comfortably as much of the tongue, the floor of the mouth, and the muscles under the tongue as may be required. The two halves of the jaw are then wired together by silver wire passed through the two holes previously drilled and the incision in the skin is sutured, while the raw area on the tongue is covered over as before described, a silk stitch being left in the stump of the tongue. The muscles under the tongue should be drawn together in the midline with catgut, and it is wise to leave a small tube protruding through the wound in the neck for forty-eight hours or so.

(3) **Kocher's Operation.** This is known as the lateral extrabuccal method, and by this method the tongue and the glands on one side of the neck can, if necessary, be removed simultaneously in one piece. This operation is particularly suitable for growths at the side of the tongue and those which involve the floor of the mouth at the side of the tongue, while by means of it a portion of the lower jaw, if necessary, can be resected should it also be involved.

An incision is made in the neck, starting just below the lobe of the ear, curving down towards the hyoid bone, reaching nearly to the midline, and then turning up to the symphysis, and the flap thus marked out is turned up. All the lymphatic glands in this region, the submaxillary salivary gland, and, if necessary, the deep cervical glands, are removed and the lingual and facial arteries tied much as in a block dissection (see p. 208). A portion of the jaw can be sawn out if necessary also. In this operation it is usually only necessary to remove half the tongue, and therefore it is now split down the middle line and the mucous membrane at the side of the floor of the mouth detached from the alveolus with scissors. The dissection in the neck is then deepened, the mylohyoid and hyoglossus muscles detached, the mouth opened into from the neck, and the tongue drawn down into the side of the neck, when it is carefully dissected free and the tissues removed as far back as the epiglottis and down to the hyoid bone. The muscular structures in the neck are then brought together with catgut stitches and the wound is closed, a drainage tube being inserted into it for forty-eight hours.

(4) **Regnoli's Operation.** The operation of Regnoli, of Pisa, may be regarded as a double Kocher operation performed on both sides of the neck. It is an exceedingly severe operation, devised for extensive growths involving both sides of the tongue or of the floor of the mouth, and is attended by a heavy mortality. So severe a procedure is it that there can be very few cases for which it is suitable. A transverse incision, curving slightly downwards, is made across the neck below the chin from one angle of the jaw to the other; the muscles are then dissected away from the jaw as freely as necessary, the mucous membrane of the floor of the mouth detached from the greater part of the length of the alveolus, the mouth opened into from below on both sides and the tongue dragged down into the neck under the jaw. The whole tongue can then be removed together with as much as is desired of the floor of the mouth and the muscles underneath it. The soft tissues are then sewn up, with temporary drainage into the neck.

(5) **Langenbeck's Operation.** This is also a severe operation seldom practised nowadays. It was devised entirely for those growths which are situated far back at the side of the tongue, and which involve the pillars of the fauces, the tonsil, or the floor of the mouth in this situation. The operation is performed by means of an incision which starts at the angle of the mouth, passes horizontally back, splitting the cheek, until it reaches the ascending ramus of the mandible, and then it runs downwards behind the angle of the jaw. The cheek is split and the ascending ramus of the

mandible sawn across, the lower fragment then being retracted downwards and the upper fragment turned outwards and upwards. By this means an extensive exposure of the back of the tongue is obtainable, and as much as necessary of this part of the tongue, the fauces, and the floor of the mouth can be removed.

Removal by Diathermy or Endothermy. This method of removing malignant growths in the tongue, fauces, palate and other parts of the mouth has been extensively used. By means of the diathermy cautery, properly used, the soft tissues can be cut almost as cleanly as with a knife, while the method stops hæmorrhage, and it is said that the heat produced causes a coagulative necrosis of the tissues and of any malignant cells there present for some little distance beyond the point severed, while the pain and discomfort following the operation are very slight. We should not recommend its use in cases which can be easily and simply removed with the knife by means of one of the simpler operations described above, but it should be employed chiefly in those cases which are sufficiently advanced to demand one of the more heroic procedures, such as those of Regnoli or Langenbeck, and there is no doubt that the method of diathermy gives much better results, with a much smaller mortality, than these very big operations. It will require, of course, removal of glands in the same way as any other procedure. It is also useful as a method of sealing over any raw surfaces left on the tongue or in the mouth after any of the above operations, in cases where suturing is not sufficient to cover up such areas; by applying the diathermy cautery lightly to these areas much pain and sepsis will be avoided.

Radium Treatment of Carcinoma of the Tongue. Within the last few years certain American and English surgeons have obtained encouraging results by the use of small doses of radium in needles, or of radon seeds implanted in and around these growths. Several needles containing 0·2 up to 2 mg. of radium bromide are inserted at the periphery of the growth with a distance of 1 cm. between each, and left in position for from six to fourteen days, the jaws and cheeks being protected by suitable shields. Radon seedlings if implanted are left in permanently, but cease to be active after about four days. The reaction is not as severe as might be expected, but the patient is extremely uncomfortable while the radium and shields are in position. Many primary growths have disappeared completely under this treatment, and the mobility of the tongue has returned, though these results have been observed only over a comparatively short period, and recurrences after one or two years are usual. Similar treatment may be adopted in the case of other carcinomata, but the results are not on the whole so good as in the case of epitheliomata in the mouth; moreover, in many cases where the primary growth disappears locally there seems no doubt that metastases appear as a result of the radium treatment in far-away parts of the body.

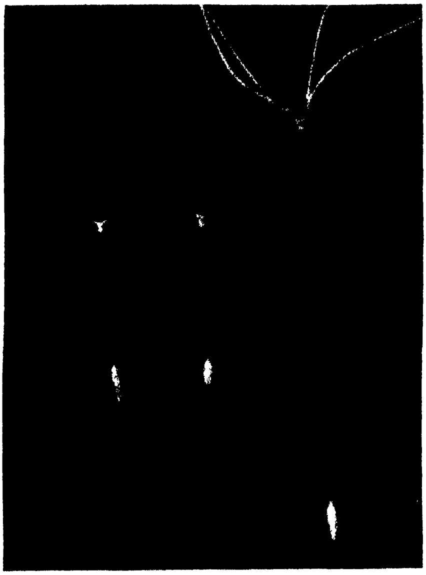


FIG. 74. Radium needles.

The glands may be treated by external application of radium applied and held in place by a moulded wax or wood shavings and gum casing, or needles may be inserted into and around them; but the results have not been as good as in the case of the primary growth, and the majority of authorities advise excision of the glands with the knife.

After-Treatment. All these operations on the tongue, especially those of Syme, Kocher, Regnoli and Langenbeck, are accompanied by a considerable mortality, usually due to septic pneumonia from the inhaling of blood and septic products during the operation. For this reason the mouth should be cleaned and rendered as aseptic as possible before the operation and intratracheal anæsthesia employed exclusively.

At the end of the operation the raw surface should be painted with Whitehead's varnish (this is Friar's balsam in which the rectified spirit is replaced by a solution of iodoform in ether). The patient should be propped upright in bed unless much shock is present, and the mouth should be washed out well with antiseptic lotion at frequent intervals during the first three days; hydrogen peroxide, Milton's solution, or solution of dichloramine-T will be specially useful. Feeding will be necessary often by means of a cup with a spout and tube on it for the first few days, while in other cases it may be done through the nose, and it is important that the patient should practise these two methods of feeding for some days before the operation is performed. After a few days he will be able to feed himself easily. The patient should have a special nurse for the first forty-eight hours, as he must be very carefully watched to see that suffocation does not occur from the stump of his tongue falling backwards; the silk stitch in the stump will control this. He should not be in bed more than three or four days unless complications set in. The tendency to chest complications is diminished if he is given six-hourly hypodermic injections of atropin, gr. $\frac{1}{100}$, and adrenalin (1–1,000), ♏v. In addition to the risk of septic pneumonia, watch must be kept for the onset of severe local sepsis, leading to secondary hæmorrhage and cellulitis of the neck. In most cases, though the speech is impaired for a few weeks, the patient soon learns to talk with comparative clearness again even if the greater part of the tongue has been removed, while the power of swallowing is soon regained.

Prognosis. The prospects of the patient remaining free from recurrence are very poor indeed, and it is unusual to find a patient completely cured of this disease, unless the operation has been performed in a very early and almost precancerous stage. Nevertheless, an effort to remove the primary growth always should be made, by diathermy if necessary, as the removal of the primary growth usually will prolong life for some months and will make him much more comfortable by removing the foul, stinking, sprouting growth in his mouth, while the death from recurrence, which is nearly always in the neck and not in the mouth, is much less unpleasant than that from the primary growth.

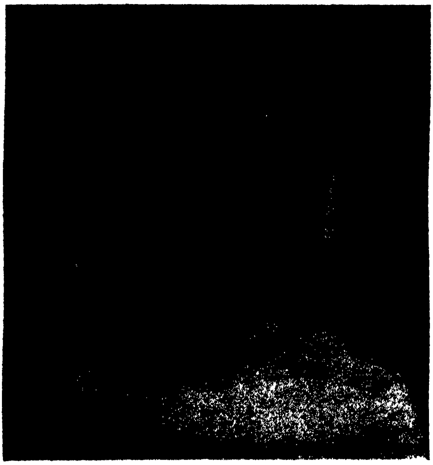


FIG. 75. Showing surface application for glands of neck: A. Position of radium containers.

The Removal of the Glands. In approximately 50 per cent. of early cases it is found on microscopic section of the enlarged glands associated with a carcinoma of the tongue that, in the early stages at any rate, enlargement is due to infection, and that carcinoma cells cannot be discovered in the glands. This being so, every effort should be made to remove the glands if possible, unless they are very large or unduly fixed, and as the removal should be as complete as possible, the operation will be an extensive one. It is best accomplished by what is known as **block dissection**, which consists in the removal of all glands, fat, fascia, lymphatic vessels and the submaxillary salivary gland from the side of the neck, leaving behind only the muscles, nerves, arteries and veins. An incision is made along the whole length of the anterior border of the sternomastoid, a second one being made from the symphysis of the chin to meet it at right angles. The three flaps thus marked out are turned up, down and backwards, and should be as thin as possible, including only the skin and the superficial fibres of the platysma. All the fat and fascia are then dissected off the muscles from below upwards, the external jugular being tied and resected, the sternomastoid retracted, and the carotid vessels being exposed and cleaned; then from above downwards, the submental and submaxillary regions are cleared, the fat, fascia, lymphatic and submaxillary glands being dissected free in one piece. This will entail tying and cutting the facial artery and Wharton's duct, while it is wise, if the tongue is going to be removed later, to tie the lingual artery. There need be no hesitation in resecting the jugular vein if necessary, but the facial and spinal accessory nerves must be preserved. In many cases the lower part of the parotid gland will be excised also. The muscles are then brought together as carefully as possible and the skin flaps carefully sutured with a small drain for forty-eight hours. This operation must not be performed on both sides of the neck on the same occasion or the skin will slough.

Inoperable Cases. With the aid of diathermy and radium the primary growth should never be regarded as inoperable, and an attempt should always be made to deal with it in order to avoid death from the primary growth itself. If for some reason this is impossible, or in cases where recurrence has occurred, very little can be done to relieve the misery of the patient. The mouth should be kept as clean as possible with antiseptic mouth washes, while pain may be relieved by the application of cocaine or orthoform, or by resection of the lingual nerve as described in Vol. I., Ch. XII. Hæmorrhage may necessitate the use of plugging or ligature of vessels, while occasionally tracheotomy or gastrostomy will be required. X-rays and radium in this advanced stage may relieve pain. Opiates should be given freely in the later stages, commencing with Tr. chloroformi et morphinæ co. by the mouth, and soon using hypodermic injections of morphia in large doses.

Neuralgia of the Tongue. Pain confined to the distribution of the lingual nerve is a not uncommon condition. It is often of a severe burning type and referred to one or other of the papillæ on the tongue, usually far back at the side of the organ, and the condition is most commonly seen in middle-aged nervous women, who frequently think they have cancer of the tongue. The pain lasts for months, and is often worse at night, while, as one of the papillæ is often prominent and red, the patient is always convinced, and the practitioner sometimes suspicious, that a malignant growth is forming; however, a similar condition always can be seen on the opposite side of the tongue, while no induration or swelling is to be felt. The patients should be assured that no cancer is present, but they are often difficult to convince. If local applications will not relieve the condition, it is sometimes necessary to resect the lingual nerve.

Spasm or paralysis of the tongue, which may be unilateral or bilateral, is seen occasionally in connection with lesions of either the trunk or the centre of the hypoglossal nerve, most frequently the former, for the nerve is likely to be damaged in operations on the upper part of the neck. When the tongue is protruded it is pushed over towards the paralysed side by the unparalysed muscles on the other side, while speech and mastication may be difficult. The paralysed half of the tongue will undergo atrophy soon, but the functional power will return largely (see Vol. I., Ch. XII.).

RADIUM APPLICATION IN GENERAL

Any action radium may have upon malignant growths is brought about by the action of its radiation either (1) destroying the malignant cells, or (2) causing them to undergo a metamorphosis so that they change back into non-malignant cells. As far as is known this latter process can occur only just before or while the cell is undergoing mitosis. It is obvious that all the cells in a growth will not be in the same stage and that some will be undergoing mitosis while others have not yet done so. This is the probable explanation of the apparent truth that prolonged dosage is important and of the modern practice of using a small dose of radium for a long time rather than a large dose for a short time.

Overdosage with radium will easily produce burns and severe sloughing as it destroys the normal tissue cells in the vicinity. A few instances have been seen of secondary or late sloughing following about six or eight months after an exposure to radium—quite unexpectedly.

(1) *Plaques.* The method of employing radium in "plaques" is still used at present very much as it was at the beginning of radium therapy.

The growth is covered by a lead screen provided with openings upon which the radium plaques are placed, screened by a few layers of paper and india-rubber. The time of exposure depends on the strength of the plaque; *i.e.*, with a plaque of normal strength, corresponding to 5 mg. of radium element per square centimetre, the time of exposure is from three to five hours, and it is sufficient to produce a strong reaction possibly followed by the disappearance of the tumour and its replacement by a supple scar after a short time.

This method is called the method of total radiation, for both β and γ rays are used simultaneously.

(2) *Intra-cavitary Application.* Highly screened tubes are introduced to normal or artificial cavities. This method is used in cases where the tumours form a stricture-like ring or line the cavities. Example: Carcinoma of the œsophagus, of the urethra, or of the bladder, and in utero-vaginal applications in cancer of the cervix uteri and in certain cases of cancer of the rectum.

It is evident that the consequence of the rapid distance decrease in the action of radium (law of the inverse square of the distance) is that deeply situated cells, *i.e.*, those that are distant from the surface of a hollow organ, receive but few rays, that is to say, not sufficient to be definitely killed; many of the lymphatics are also outside the efficient action of the gamma rays which are screened off by the metallic apparatus containing the radium.

With these methods, good results are only obtained in cases of cancer of the cervix uteri.

(3) *Interstitial Method.* At the beginning of radium therapy, the idea occurred to Dominici of imbedding small radium tubes into the tumour and placing these so as to obtain a fairly homogeneous distribution of the dose. This improved method has brought about *radium-puncture.* The radium is enclosed in needles which are pushed into the cancerous tissues or into those that are liable to be invaded, and this method distributes small doses of radium fairly evenly.

This method is particularly useful in localised cases such as carcinoma of the lips, of the tongue, of the tonsils, of the breast, of the vulva, of the penis and certain cancers of the skin.

Radium-puncture is also used after a means of access to the tumour has been created by means of an open operation.

(4) *Distant Radium Therapy.* This name implies a series of methods intended to radiate homogeneously and efficaciously the tumours that have invaded the lymphatics, without inserting radium into the body in any form.

Plastic material such as wax and "Columbia paste" is used to make the apparatus for holding the radium at a short distance.

Properly screened radium tubes are distributed on the exterior surface of these moulds as evenly as possible and in such a way as to radiate both the surface and the deeper parts.

If the lesions appear to be deep, the tubes should be kept at the same distance as far as possible, so that the strength of radiation is very evenly divided in the deeper parts. The appliances for fixing the tubes are made of wood shavings according to the methods that have been in use for several years past at the Brussels Radium Institute.

The distance between the tubes and the skin is from 4 to 6 cm., though in some of these appliances there is as much as 10 cm. distance between the skin and the radium. (See also Vol. I., Ch. XXIII.)

THE SALIVARY GLANDS

Surgical Anatomy.

(*a*) *The Parotid Gland.* This gland is in intimate relationship with the front part of the ear and the back part of the ramus of the mandible and temporo-mandibular joint. It is encased in a firm layer of fascia which separates it from the skin and superficial structures over it, and is sufficient to retain pus and inflammatory products for a considerable time. Superficial to this fascia lie the preauricular lymph glands just in front of the lobule of the ear. In front of the main portion of the gland and on the masseter muscle lies the facial portion, while Stenson's duct leaves the gland, and runs across the masseter for about two inches; it then turns in at a right angle, pierces the buccinator and the mucous membrane and enters the mouth opposite the second upper molar tooth, while the surface marking of this duct is shown by a line drawn from the upper part of the lobule to a point midway between the ala of the nose and the border of the upper lip.

The facial nerve runs through the lower part of the gland, emerges and runs across the face, slightly below Stenson's duct. The deeper part of the parotid gland is in contact with the internal carotid artery, the internal jugular vein and the 9th, 10th, 11th and 12th cranial nerves, while the external carotid divides into its two terminal branches within the substance of the gland.

(*b*) *The Submaxillary Gland.* This lies under the deep fascia of the neck immediately below and in front of the angle of the lower jaw, and under cover of its ramus. It consists of a larger superficial and smaller deep lobe, the latter wrapping round the posterior margin of the mylohyoid muscle from which portion the duct emerges. Upon and under the gland and closely attached to it are several lymphatic glands, while the facial artery runs through its substance. Its duct (Wharton's duct) opens at either side of the frænum of the tongue.

(*c*) *The Sublingual Gland.* This lies in the floor of the mouth and is found immediately beneath the mucous membrane on either side of the frænum of the tongue. It is the smallest of all the glands and opens through the mucous membrane of the floor of the mouth immediately superficial to itself by several small ducts (the ducts of Rivinus).

Sialography. Lipiodol may be injected up the parotid duct with a very fine syringe. An X-ray film will then show the course of the duct, and may be of value in the case of a salivary fistula.

Injuries of the Salivary Glands and Ducts. Injuries of the submaxillary and sublingual glands are very uncommon. They lead to no symptoms of note and usually escape observation altogether.

The parotid gland and its duct, however, frequently are damaged either by accidental or operation wounds. If the gland is injured, as is not infrequently the case, during operations for removal of lymphatic glands from the upper part of the neck, hæmorrhage from the vessels is often profuse and these may be difficult to pick up and tie. A small quantity of saliva escapes from the gland at the time, but in most cases such wounds heal rapidly and no further trouble is experienced. Should the wound become infected, however, saliva will escape and healing be delayed, while a salivary gland fistula may form (see below).

Wounds injuring the parotid gland are liable to damage the facial and the auriculo-temporal nerves and other important structures.

The parotid duct is injured not infrequently, and in this case a salivary duct fistula is likely to form (see below), while such an injury sometimes will result in a salivary cyst forming in the cheek as the result of a dilatation of the duct after it has healed. This condition gives rise to a cystic swelling in the cheek, increasing in size after each meal, but which can be emptied into the mouth by pressure.

In the case of a wound of the parotid gland or duct, the skin over it should be stitched together carefully by stitches which are close to each other, but which do not include or compress the duct itself.

Salivary Fistulæ. These are practically confined to the parotid gland and its duct.

Parotid Fistula. This is a fistula emanating from the gland substance, and is usually due, not to a wound, but to suppuration in the gland or abscesses forming around a calculus which have required opening. The condition is usually seen as a very small pin-point opening at some point over the gland,

and without any granulations projecting from it. Little or no fluid escapes between meals, but at meal-times the saliva runs out in quantities as a clear, limpid, watery fluid. A parotid fistula of this kind usually heals spontaneously after many months, but it often can be assisted by deep X-rays, insertion of radium, cauterising the track or scraping and suturing its edges. Section of the auriculo-temporal nerve will stop the secretion of saliva.

Fistula of Stenson's Duct. This is much more serious, and is usually due to a wound, accidental or operative. Such a fistula shows no tendency to close spontaneously, while the portion of the duct in front of the fistula often becomes fibrosed and obliterated. From its opening, which is usually in front of the masseter, the saliva flows in a continuous clear stream, greatly increased at meal-times, this continual stream of fluid running down the cheek, causing great inconvenience to the patient; it must be remembered that parotid saliva is much thinner and more liquid than that from the other glands.

Treatment. This is a most troublesome condition to treat, as any attempt to close the opening with the cautery, or by paring and suturing its edges, or by sealing it with collodion, usually fails. The treatment will depend very largely on whether the opening is over the masseter or the buccinator. In either case deep X-rays or insertion of radium into the fistula and over the adjoining gland will usually effect a cure.

If the opening is over the buccinator, it is usually sufficient to slit up the duct within the mouth, carrying the incision up as far as the fistula. By this means the saliva can get into the mouth more easily than out on to the cheek, and then the fistula will close.

If the fistula is over the masseter, and the nearer it is to the gland itself, the more difficult it is to close it. It is sometimes possible to dissect up the fistula as far as the main duct, make an opening through into the mouth, transplant the fistula bodily through this opening and close the skin over it. In other cases, by means of a fine probe and silk ligature, a fine drainage tube may be carried up the duct from the mouth and left with one end projecting into the mouth and the other out through the fistula, and tied in this position. By this means the saliva may be conveyed back to the mouth, and after a few days the tube is drawn down a short distance into the mouth so that it no longer projects out through the fistula. Finally the tube is replaced by a thick silk ligature and the external opening may gradually close, provided that the way through into the mouth is kept patent.

In some cases the peripheral buccal portion of the duct is obliterated and obstructed by scar tissue, and then a fresh opening must be made through into the mouth as near the fistula as possible, and this opening be kept open with a tube and silk ligature as above described.

Salivary Calculus. A salivary calculus may be met with in any of the salivary glands or in their ducts, but it is by far the most common in connection with the submaxillary gland. Those which occur in the ducts form elongated cylindrical stones composed of phosphate and carbonate of calcium, with usually a small nucleus consisting of organic matter such as epithelial debris, mucin or bacteria. They are not often very large and are usually of a whitish colour. They are seldom seen in the parotid gland, probably because its saliva is much more liquid in character. The stones which form in the gland substance are much more irregular in shape than those formed in the duct.

The symptoms to which these stones give rise consist, firstly, of *salivary colic*, which takes the form of a sharp stabbing pain along the line of the affected duct, coming on in attacks and usually becoming considerably worse during meals, while, secondly, salivary obstruction in the duct concerned will be present. This obstruction is not usually complete, so that a certain amount of saliva can pass down the duct until the gland becomes active during meal-times. When this occurs the saliva cannot all get away, and then painful swelling of the gland concerned occurs rapidly during the meal, while the swelling can be emptied by pressure and gradually disappears in between meals. After this obstruction has been present for some little time the gland becomes permanently enlarged, being hard, swollen and adherent to the surrounding tissues. Infection of the duct and gland is then liable to occur and give rise to a subacute sialo-adenitis, which even may pass on to abscess formation. This is most likely to occur in the rare instances when the obstruction is complete, for in this case a large retention cyst may form and become infected, or even burst and give rise to a salivary fistula. In addition to the above signs and symptoms, when a calculus is present it usually can be felt either by a probe passed along the duct or by the finger, or most commonly by one finger inside the mouth and another under the jaw. It will be visible in an X-ray picture, while the mouth of the duct usually appears red, swollen and œdematous, and it frequently will be seen to discharge a certain amount of offensive muco-pus. In some instances, especially when the calculus is in the gland and not in the duct, the hard, tough, adherent indurated swelling which forms there as the result of chronic inflammation will resemble a new growth.

Obstruction of a salivary duct sometimes may be due to the formation of scar tissue as well as to the presence of a calculus.

The hard swelling in the floor of the mouth caused by the stone, combined with the swelling in the neck due to the enlarged gland, sometimes has been mistaken for a carcinoma of the floor of the mouth with secondary glands in the neck.

Treatment. Many of these calculi will pass out of the duct spontaneously if left alone for a few days, while sometimes they may be dislodged with a probe. If this cannot be done and the calculus can be felt easily, the mucous membrane over the duct should be anæsthetised with cocaine, incised, and the stone removed. In many cases the condition is recurrent, calculi frequently forming in the duct and in the gland. This occurs especially in the submaxillary gland, when by far the best treatment is complete excision of the gland.

When a stone has been impacted in the duct, stenosis of the lumen will follow sometimes and give rise to chronic sialo-adenitis. Such a stricture may be dilated by passing probes up the duct, or a fresh opening may be made between the mouth and the duct above the stricture. If this fails, the gland must be removed.

Ranula. A ranula is a cystic tumour forming in the floor of the mouth under the tongue. It was at one time thought to be a retention cyst due to blocking of one of the ducts of Rivinus or even of Wharton's duct, but this is not so, and there is little doubt that the condition is a retention cyst or a degeneration cyst occurring in some of the large mucus-secreting glands under the tongue, and usually known as the glands of Blandin and Nuhn. A ranula contains a sticky, clear fluid containing mucin and albumen and no salivary ferment. The swelling occurs under the tongue just to one side of the frænum, where it gives rise to a large, smooth, round, painless, bluish, fluctuating mass, the mucous membrane over it being very thin and quite freely movable upon it. The swelling may become very large (as big as an egg), and then it will push the tongue up and to one side and even interfere with speech and deglutition. Wharton's duct usually will be found lying along one side of the swelling. This condition is most common in young people, and if it is not treated the swelling ultimately will burst, discharge its contents, and then slowly fill up again. The bluish colour of a ranula will distinguish it from a dermoid cyst in this situation.

A *congenital ranula* is occasionally seen, and appears in the form of a somewhat similar cystic swelling just under the mucous membrane of the floor of the mouth in new-born children. This is probably due to a congenital obstruction or lack of development of the duct of Wharton or of Rivinus; such a ranula is placed rather deeper in the floor of the mouth than the variety above described, and it usually can be seen and felt in the neck just below the chin.

Treatment. The ideal treatment would be to dissect the ranula out completely, but this is almost impossible, owing to its size and the extreme thinness of its wall. In practice, therefore, the best treatment is to incise the cyst inside the mouth, let out its contents, and dissect away as much as possible of the cyst wall. It is of extreme importance that the whole lining of the cyst should be destroyed, and therefore, if the wall cannot be completely dissected away, the remaining portion of it should be curetted and swabbed with a solution of zinc chloride (50 grains to the ounce); the cavity left must then be packed with a strip of gauze and allowed to heal slowly from the bottom by granulation, the packing being replaced every day for the first week and gradually reduced in size. If any portion of the lining membrane is left undestroyed, recurrence of the cyst is certain.

The congenital type can be removed completely by dissecting them out from the neck.

Infections of the Salivary Glands

The Parotid Gland. The parotid gland is that most frequently affected by inflammatory disease, and the process may be suppurative or non-suppurative. Non-suppurative inflammation is seen in two forms:

(1) **Epidemic Parotitis (Mumps).** This is an acute infectious condition usually seen in children, in whom it attacks both of the glands, usually within a few days of each other. The parotid rapidly becomes swollen, hard and very tender, swallowing, opening the mouth, laughing and talking being particularly painful, while the temperature rises to a moderate degree. The skin over the gland is shiny and tense, but not œdematous. The swelling and pain are not affected by meals, last for about a week and then gradually settle down, while in rare instances the submaxillary and sublingual glands are also enlarged. The disease is highly infective, the incubation period being from fifteen days to three weeks.

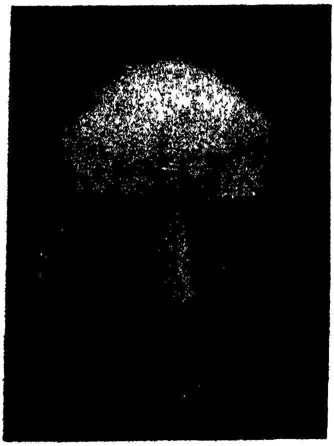


FIG. 76. Mumps.

Suppuration in this condition is unknown, but it is not infrequent for the disease to involve the testicle, the ovary, the breasts or the pancreas. The orchitis of mumps occurs especially in adults, in whom it is usually a pure orchitis, while in younger patients it is not infrequently an epididymitis. The testicle becomes exceedingly swollen and painful, and the scrotum red and œdematous, while there may be a mucous discharge from the urethra, and fever may be very high. Luckily the condition is usually unilateral, as atrophy of the testicle often follows. In females the breasts may become swollen and tender, while pain in the ovary may be felt. Severe pain in the epigastrium, with vomiting, is due to pancreatitis ; this soon settles down.

Treatment. The patient should be put to bed, kept warm and given a light diet and saline aperients and should be isolated for three weeks.

(2) **Simple Parotitis.** A subacute inflammation of a mild kind, usually confined to one parotid, is seen not infrequently, the gland suddenly becoming swollen and tender, while there may be a small amount of fever and malaise. This disease is sometimes due to injury or exposure to cold, to the presence of a calculus in the gland or its duct, while it also occurs in gouty subjects, in those taking potassium iodide or mercury, and in people suffering from chronic infections of the mouth or of the genito-urinary tract. It is said that glass-blowing or playing wind instruments tends to make the ducts dilate and thus render infection easier. A somewhat similar but more severe condition is sometimes seen after abdominal operations (see below). No treatment is required, as the condition soon settles down if its cause is removed.

Acute Suppurative Parotitis. This is a far more serious condition, and is due to the invasion of the gland by septic organisms which usually reach it by spreading from the mouth up Stenson's duct. In other cases the organisms invade the gland by means of a pyæmic process, as in such diseases as typhoid, scarlet fever, diphtheria, or measles, or by direct spread of suppuration from the jaw or other neighbouring structures, such as lymphatic glands or the temporo-mandibular joint. Chronic diseases such as diabetes, chronic nephritis, lead poisoning, or general paralysis of the insane also predispose to this affection.

A serious form of the condition is met with as a complication after abdominal operations, especially those for such septic conditions as acute appendicitis, perforated gastric ulcers, etc. In these cases it is probable that the spread of the infection up Stenson's duct is assisted by the dryness of the mouth and lack of oral feeding, as the condition is sometimes seen in other patients who are undergoing prolonged rectal feeding for any reason.

In this condition the gland rapidly becomes enlarged, extremely tender and painful, while the skin over it becomes red, congested and œdematous. There will be high fever and severe general reaction, though these features will be masked if the patient is already suffering from some other severe general disease. The gland is at first hard, but later softens and fluctuation sets in, usually about the third day. There is great difficulty in speaking and swallowing. When the suppuration sets in, the pus will be found scattered throughout the gland, the tissues of which may slough. The dense parotid fascia over the gland prevents the pus finding its way to the surface, and thus it tracks and burrows in different directions down among the muscles of the neck or towards the mediastinum, towards the pharynx and base of the skull (where it may form a retropharyngeal abscess), or into the temporo-mandibular joint, while in other cases it will burst into the external auditory meatus or into the pharynx through the sinus of Morgagni. The socia parotidis in front of the gland can usually be felt to be enlarged and tender. The prognosis is grave, as thrombosis of the large veins in the neighbourhood leading to pyæmia is likely, while toxic absorption is severe. Erosion of the jugular vein or large arteries near the gland may occur and lead to severe hæmorrhage, while the condition is not infrequently followed by salivary fistula and facial paralysis.

Treatment. For the first few days hot fomentations and Klapp's suction bell should be employed, the mouth being kept as clean as possible with antiseptic washes while sulphanilamide drugs are given. The injection of 25 c.c. of horse serum in the early stages is often valuable in improving the condition. As soon as pus is formed it should be let out, an incision being made parallel to the facial nerve over the swelling or vertically behind the angle of the jaw and the abscess being opened by Hilton's method. A finger must be passed into the gland to break down any septa and open into the various loculi, while the gland should be drained for some days by means of rubber tubing.

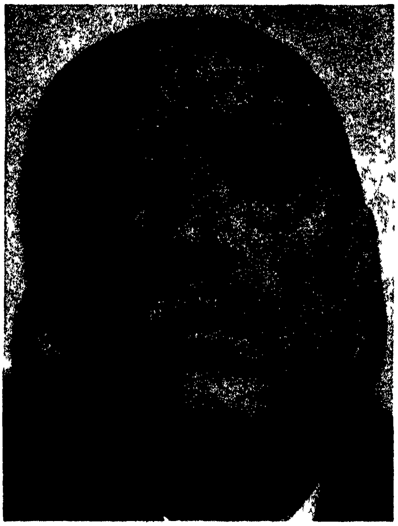


FIG. 77. Von Mikulicz's disease, showing enlargement of the lacrimal, parotid and submaxillary glands on both sides.

Submaxillary and Sublingual Sialoadenitis. Acute infection of these glands arises in exactly the same way as that described above, and its clinical features are similar, but the condition is much more rare and less serious. In the case of the submaxillary gland infection is liable to spread outside the gland and give rise to Ludwig's angina (see p. 399).

In the case of the sublingual gland an exceedingly painful, tender swelling forms under the tongue, which is pushed up towards the roof of the mouth. Œdema of the glottis and respiratory obstruction may occur. In either of these cases an incision into the swelling to let out the pus should be made as soon as possible.

Salivary Tuberculosis. It is doubtful whether primary tuberculosis of the salivary glands ever occurs. They may be involved, however, secondarily by spread from the lymphatic glands in contact with them ; when this occurs the condition is usually indistinguishable from the disease of the neighbouring glands. The salivary gland affected should be removed with the diseased lymphatic glands.

The salivary glands are occasionally enlarged and hard in syphilis.

Von Mikulicz's Disease. This is a rare disease met with in adults which consists in a more or less symmetrical, slow, painless enlargement of the lacrimal, parotid and submaxillary glands on both sides. In some cases the sublingual glands are involved as well, and the lacrimal glands are frequently enlarged and may be seen and felt projecting from the orbit. The cause of the disease is unknown, but it is probably due to some form of chronic inflammation.

The condition usually commences in the parotid glands, one of which slowly becomes swollen, hard and at times slightly tender, a similar condition spreading to the other glands, while the increase in size may progress slowly for many years, leading in time to considerable deformity, sometimes accompanied by dry mouth due to a deficient secretion of saliva. In some cases the gland appears to enlarge slightly at meal-times. Apart from the deformity, the disease gives rise to no symptoms, while the swellings are smooth, firm, and not adherent to surrounding tissues.

In some instances the condition is accompanied by the blood changes of lymphatic leukæmia and by splenic and glandular enlargements; these cases usually die, but those without blood changes tend to become chronic, and sometimes undergo spontaneous cure within a few years.

Treatment. The pathology being unknown, any treatment has to be empirical, and it is found that arsenic, iodides, thyroid extract, and X-rays have all been beneficial.

Tumours of the Salivary Glands. Though occurring in all the salivary glands, new growths are seen far more commonly in the parotid. The following description, therefore, refers to parotid tumours, which may be simple or malignant.

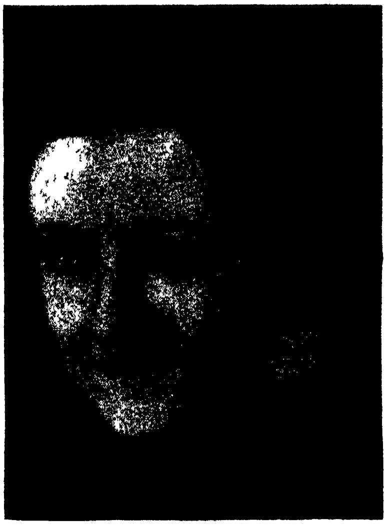


FIG. 78. Mixed tumour of the parotid.

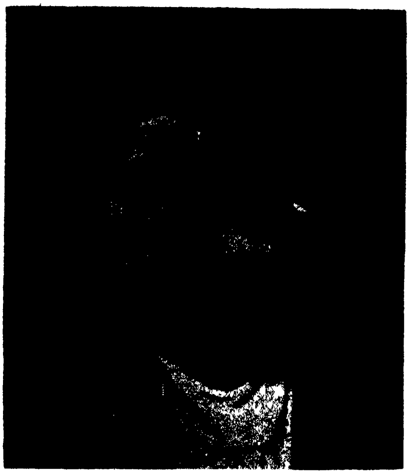


FIG 79. Advanced malignant tumour of parotid.

(1) **Mixed Tumours of the Parotid.** This is the commonest simple tumour, and its pathology is not known for certain. On microscopic section it consists of a heterogeneous mass of cells of endothelial type, which lie in a matrix made up of fibrous, myxomatous, nævoid, cartilaginous and lymphoid tissues. It has, therefore, been described as an endothelioma, or sometimes as a myxochondro-endothelioma, and by some is thought to arise from the endothelial cells of the lymph and blood vessels of the gland. Most authorities regard these tumours as all being of epithelial origin (basal-celled carcinoma) with differing degrees of cell differentiation and rates of cell division, and areas of degeneration in them. It is possible that it arises in rests connected with the first branchial arch, and is really a *teratoma*, and that some of the varieties of tissue met with are due to mucoid or colloid degeneration. In old-standing cases there appear at times to be certain malignant elements in the tumour. In some cases cysts containing gelatinous fluid are present, and there is

evidence that after being present for some years these growths tend to become malignant. The tumour commences in the parotid gland, usually in its superficial part in front of the auditory meatus: it does not infiltrate the gland, but presses the glandular tissue aside; it appears to have a definite capsule, while its mucinous matrix may look like cartilage.

Clinical Features. The condition usually starts about the age of thirty, but may appear earlier, and gives rise to a slow-growing, painless, rounded nodular swelling in the situation of the parotid gland, generally commencing about the level of the lobe of the ear, from under which it bulges out. Areas of softening sometimes will be felt in the swelling, while when it gets large it appears to be jammed in between the jaw and the sterno-mastoid muscles, and processes of the growth extend over the masseter and down to the styloid process. The skin over the swelling becomes thinned, but remains unattached, while the tumour is freely movable in the early stages, and there is no tendency to lymphatic gland invasion. When the tumour gets bigger it will interfere with mastication, and will become more fixed, while it is exceedingly uncommon for it to involve the facial nerve unless or until it becomes malignant. After growing for many years these tumours become malignant, as is shown by their suddenly becoming painful, starting to grow rapidly, infiltrating the skin and surrounding tissues, giving rise to lymphatic gland enlargement and causing facial paralysis.

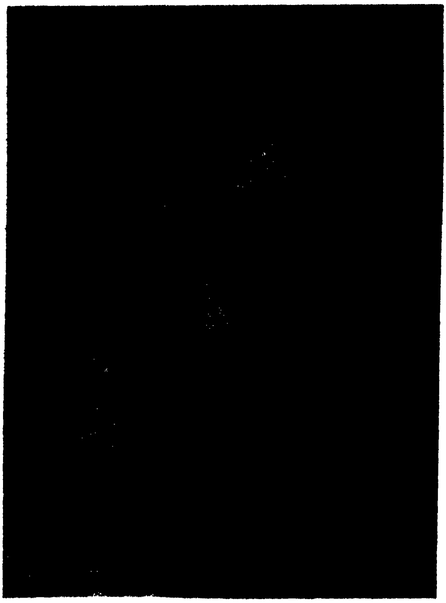


Fig. 80. Malignant parotid tumour.

It is highly probable that the various tumours which have been described as fibroma, adenoma, etc., of the parotid really belong to the above class.

(2) **Malignant Parotid Tumours.** The commonest form of malignant parotid tumour is that due to a mixed tumour which has later undergone malignant change. More rarely a pure sarcoma or carcinoma of the gland is seen; these are rare and very malignant. The former usually occurs in small infants, when it rapidly reaches an enormous size. The signs of malignancy

in a parotid tumour are rapid growth, extreme hardness and pain, fixity of the mass to the surrounding parts and to the skin, pressure upon vessels and nerves, and especially upon the facial nerve, which is a very important sign ; the neighbouring lymphatic glands become extensively infiltrated and enlarged, while finally ulceration and even fungation may occur : malignant cachexia will then set in, and in some instances distant metastases.

Treatment. The simple parotid tumours usually lie superficially upon the gland, and, therefore, can be shelled out comparatively easily, though even in these growths care must be taken not to injure the facial nerve or Stenson's duct. On account of the possibility of malignant transformation they always should be removed, and in these simple cases if removal is complete recurrence is highly unlikely. A flap of skin and subcutaneous tissue should be turned forwards or upwards, the growth exposed and carefully dissected out. The facial nerve usually lies deep to the growth, but this must not be relied upon, as it sometimes runs through the tumour. Hæmorrhage is free, but can be controlled easily.

With regard to the malignant cases, not many of them are operable. If the skin is extensively involved, if the growth appears to be fixed in the deeper parts, if it is very large, or if secondary deposits are present in the lymphatic glands around, no attempt should be made to remove it. If operation seems advisable a big skin flap is turned up and the whole gland as far as possible dissected out by commencing at the bottom part, tying the external carotid artery and drawing the gland upwards. The facial nerve must be sacrificed, and the patient should be warned of this beforehand ; while it is also necessary to remove the cervical glands. Removal of the angle of the jaw will give an increased amount of space, but as recurrence is almost certain to follow whatever is done, this does not seem justifiable. After operation and in inoperable cases radium or deep X-rays should be used but give poor results.

(3) **Submaxillary and Sublingual Tumours.** Exactly similar tumours occur in these glands, their clinical features being the same, but their situation different. Tumours of these glands are more easily removed than in the case of the parotid gland. The submaxillary and sublingual glands are frequently invaded by epithelioma of the tongue and floor of the mouth, either directly or from the secondary lymphatic glands.

Preauricular Lymphadenitis. The preauricular lymphatic glands which lie upon the parotid fascia in front of the auditory meatus are often involved by tuberculosis, or by septic inflammation which usually comes from the scalp or eyelids. In the former case a cold abscess is formed, which may resemble a cyst. In these conditions the glands should be removed through a small incision.

Xerostoma (Dry Mouth). Lack of salivary secretion is sometimes seen as a terminal event in very weak and debilitated patients. In other cases it is the result of a chronic infection of the salivary glands, often due to oral sepsis. It gives rise to dry, scaly lips, while the tongue is dry and fissured and the gums glazed ; in some instances it is accompanied (especially in women) by dry, harsh skin and loss of taste. All septic teeth should be removed and the condition probably will clear up.

Ptyalism (Salivation). This is the reverse condition, in which a great excess of saliva is formed. It may be swallowed or may escape from the mouth. It may be due to mercury, nervousness, trigeminal neuralgia, cutting teeth, earache, and such nervous diseases as general paralysis, hydrophobia, bulbar palsy, etc. It is best treated by means of small doses of atropin and opium and a permanganate of potash mouth wash.

CHAPTER VI

DISEASES OF THE EYE

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Introduction

A KNOWLEDGE of the condition of the eyeball, and of the evidence, which can be gained from an examination of it, of past and present disease, is often of use to the surgeon and also sometimes may provide a hint as to prognosis. It is from this point of view that the following chapter has been written, and it is hoped that it will be of use. The detailed examination and correction of errors of refraction are not dealt with.

When a patient arrives at the ophthalmic outpatient department, " Why do you come ? "—the first question asked him—should elicit the most prominent symptom and ensure attention to it. Near and distant vision should be recorded and a general survey made, not only of his two eyes, but of the patient's general appearance, gait and mental activity. Oral or nasal fœtor or the presence of a rash upon face or hands should be recorded, an examination of the teeth and nasopharynx may be useful ; a note should be made of such abnormalities as a squint, a tumour, undue prominence of one or both eyes, or abnormal ocular movements. This being completed, the lids, conjunctiva, cornea, iris, lens, vitreous and retina of each eye should be examined in a routine manner, remembering that in any *pair* of organs *both* should be examined before an opinion is given on one of them. The examination should include the testing of the pupil reactions for light and accommodation, making pressure over the lacrimal sac while the punctum lacrimalis is scrutinised for regurgitation of fluid, and the taking of the intraocular tensions by the clinical method. The examination of the eyes is then fairly complete. Still further information can be gained by plotting the patient's field of vision for white and colours, both for peripheral defects or central scotomata, and by investigating his colour vision. It is sometimes impossible to report upon the condition of an eye without dilating the pupils.

The Visual Function. The visual function is tested by asking the patient to read with each eye separately letters of certain sizes from a fixed distance of 6 metres. It is estimated by the angles which they subtend that these letters should be visible to the normal eye at certain distances. The letter at the top of the test card is of such a size as to be visible at 60 metres, those on the second row being visible at 36 metres, and so on down the card at 24, 18, 12, 9 and 6 metres respectively. If the patient has full vision he will read, from 6 metres, the line intended to be read at that distance, and it will be said that his vision is 6/6ths. If he only reaches the third line his vision is 6/24ths, and so on. Having taken the patient's distant vision, his near vision should be tested by asking him to read small types of various sizes printed on a card. These should be held at a distance of 11 inches from his eyes. The near vision test should follow immediately that for distant vision. If omitted here it almost certainly will be forgotten later, and thus a valuable hint may be lost.

If the patient cannot see even the top letter from 6 metres, he must be approached to the test types until he can see this object. According to the distance at which he has to stand to achieve this, his vision may be recorded as 1/60th, or more. If he cannot read the top letter even at 1 metre he should be placed before a good light and asked to count fingers held before him. If he can do this correctly his vision is recorded as "c.f." (counting fingers). Suppose him unable to count fingers, he yet may be able to distinguish hand movements. If so, his vision is said to be "h.m." (hand movements). Some cases still remain where the patient is unable to see even "h.m." He should be taken into the dark room and seated with his back to the light. His attention should be directed to a hand held in front of him, upon which light from the dark room lamp falls. It may be found that he is able to perceive the light which is reflected upon his eyes from the palm of the hand. If so, he is said to perceive "h.r." (hand reflex). Still another grade of vision should be investigated, even when all the above tests fail. The patient should remain seated in the dark room with the lamp behind him and light should be reflected from the lamp upon his eye by means of a plane mirror. If he can perceive this he is said to have perception of light ("p.l."). If he cannot perceive this he has no perception of light (no "p.l.") and the eye is said to be blind.

ERRORS OF REFRACTION

Emmetropia is said to be present when the anteroposterior length of the eyeball and the refractive power of the media are so adjusted that parallel rays of light entering the eye are automatically brought to a focus upon the retina. Rays of light emanating from objects at a distance of 6 metres from the eye are considered as being parallel when they reach it.

Hypermetropia results from shortening of the eyeball in its anteroposterior axis or alteration of the refractive media so that parallel rays entering the eye come to a focus behind the retina, unless the ciliary muscle is brought into action, and the curvature of the lens altered, to overcome the error. Alternatively *plus* (convex) lenses may be placed before the eye to provide the necessary increase of power by artificial means.

Myopia occurs when the adjustment of relations is disturbed in the opposite direction. The anteroposterior length of the eyeball is now too great in proportion to the refractive power and parallel rays are brought to a focus in front of the retina. The ciliary muscle, when it contracts, reduces the circumference of the ciliary ring and relaxes the tension of the suspensory ligaments of the lens, the curvature of which then increases from its elasticity. In myopia, therefore, accommodation can only make matters worse. The correction of myopic eyes consists in placing *minus* (concave) lenses before the eye to increase the focal length of the media until this is adjusted to the increased anteroposterior length of the eyeball, when parallel rays entering the eye will come to a focus on the retina.

Accommodation and Presbyopia. The power of the ciliary muscle to alter the refraction of the ocular media by acting on the crystalline lens through the suspensory ligaments is very great in infancy, but begins to fail almost at once and continues to do so throughout life. At forty years of age the power of accommodation is reduced tc 4 dioptres.

In the emmetropic eye parallel rays from objects at a distance of 6 metres from the eye are brought to a focus upon the retina.

When the ciliary muscle is at rest, to bring rays from an object 1 metre distant from an emmetropic eye to a focus upon the retina, an accommodation effort of 1 dioptre is required. Similarly, if the object is placed ¼ metre away, the necessary accommodation effort to produce a focus is 4 dioptres. It is at this distance (11 inches, or 23 cms.) that we usually hold our books and do close work. At forty years this is still possible, but after this age reading becomes increasingly difficult, and we hold the book progressively further and further from us, thus reducing the amount of accommodation.

If hypermetropia is present the difficulty occurs before the age of forty. For the correction of this defect—*presbyopia*— + 0·5 dioptre must be added to the distance correction, whatever this may be, for every five years after forty, on the understanding that not more than + 3·0 dioptres should be added as a presbyopic correction.

Astigmatism. In simple hypermetropia and myopia a pencil of rays entering the pupil is brought to a focus by the refractive media at some definite point *stigma,* either in front of or behind the retina. In astigmatism the refractive power of the ocular media differs in different meridia. Taking, for example, two meridia, A and B:—at the points where the rays in meridian A have been brought to a focus the rays in meridian B are still convergent, while at a point where rays in meridian B are brought to a focus those in meridian A have passed beyond this phase and are commencing to diverge. Hence at no position are all the rays brought to a focus at a point. The nearest approach to this occurs at two points where two geometric lines represent the positions at which the rays in meridia A and B respectively are brought to a focus. By a compromise a somewhat blurred image of the object can be obtained at an intermediate point. Astigmatism is either *regular* or *irregular.* In the former the two meridia A and B are at right angles to each other and the error can be corrected by cylindrical lenses. In the latter this is not the case, and the error is not capable of correction by glasses.

Regular astigmatism, when in one meridian the refractive media are emmetropic while in the other hypermetropia or myopia is present, is called "simple." If both meridia show an error which is similar in kind, but different in degree, the astigmatism is of the "compound" type. While if an error is present which is hypermetropic in one meridian and myopic in the other, a "mixed" astigmatism is present.

Irregular astigmatism results from the scarring which follows corneal ulcers and wounds. Both regular and irregular astigmatism give rise to persistent headaches, and small amounts will impair, often seriously, the acuity of vision.

Amblyopia is a condition of low visual acuity in one or both eyes, for which no obvious cause is assignable. Two possible explanations should be familiar to the surgeon and receive his consideration. In both of them the fundus oculi on both sides is usually perfectly normal.

1. Conduction of visual impulses along the optic nerve and tracts may be at fault. This occurs in retrobulbar neuritis due to disease of the central nervous system or to a general or local toxæmia which may be endogenous or exogenous. Toxic amblyopia due to tobacco poisoning should always be excluded when the vision of both eyes is peculiarly bad without physical explanation, especially when it is even worse for near than for distant vision.

2. Education of the optical centres in the calcarine fissure of the cerebral cortex may be deficient and give rise to *amblyopia ex anopsia.* This question is intimately connected with those of squint and binocular vision.

It is found that in anisometropia—one eye being very different from the other in its refractive error—the eye with the greater, especially the more astigmatic, error cannot be improved to the visual acuity obtainable in isometropic cases. A squint may or may not be present in the defective eye. When no squint is seen the patient often (though not necessarily) will give a history of having squinted in childhood during whooping cough or when tired. In such cases it is assumed that the patient has educated the cortex in association with his more emmetropic eye to the partial exclusion of that connected with the defective one. We have two facts in confirmation of this theory. It is nearly always possible, especially in children, to improve amblyopia and possibly an associated squint by the provision of adequate glasses and covering up the eye which sees the better, so that the " amblyopic " eye may be encouraged to improve its visual acuity by use. Secondly, it has been noted that when the sight of the better eye has been lost by trauma or disease later in life that of the defective one begins to improve and continues to do so.

INSTRUMENTS AND METHODS OF EXAMINATION

Three instruments are necessary for the examination of an eye :—

The lens.
The loupe.
The ophthalmoscope.

The Lens. A convex lens of 13 dioptres optical value is used to focus light obliquely upon the lids and eyeball to obtain good illumination of the structures under observation. It is also useful for indirect ophthalmoscopy. That supplied in the ophthalmoscope case is quite efficient.

The Loupe. A magnifying glass of magnifying power 6 to 10 diameters and short focal length (about 2 cm.) is used through which to observe the structures illuminated by the 13 D. lens.

Examination with the lens and loupe is extremely important. To examine the *right* cornea the source of light should be placed to the right of the patient's head. The surgeon standing facing him holds the lens between the first finger and thumb of his supinated left hand at right angles to a line drawn from the light to the patient's eye and at about 8 cm. from the latter and focuses the light upon the cornea. The patient's *lower* lid can be depressed by the surgeon slightly flexing the second finger of his left hand without moving the lens.

The loupe held between the thumb and first finger of the pronated right hand should now be brought up into position and held at about 2 cm. from the cornea so as to magnify the area obliquely illuminated by the lens. The surgeon lifts the *upper* lid by extending the second finger of his right hand without moving the loupe.

To examine the left cornea the positions are reversed. The surgeon's right hand controls the lens and lower lid while his left holds the loupe and lifts the upper lid.

With a little practice the position of the lens and loupe may be varied so that the anterior surface of the patient's crystalline lens, his iris and the posterior surface substance and anterior surface of his cornea may be illuminated and examined under magnification in turn.

The disadvantage of this method is that it loses the stereoscopic effects of binocular vision. This can be overcome by using a binocular loupe. This instrument is usually fixed upon the surgeon's head by means of an elastic band, leaving the hands free to move the source of light, manipulate the lens and separate the eyelids.

Recently the "*slit-lamp*" has introduced a still more perfect means of examination by focal illumination. Here by means of special apparatus a very bright slit-like beam of light is thrown obliquely upon the eye, and accurately focussed (so as to have sharp edges) upon the various structures

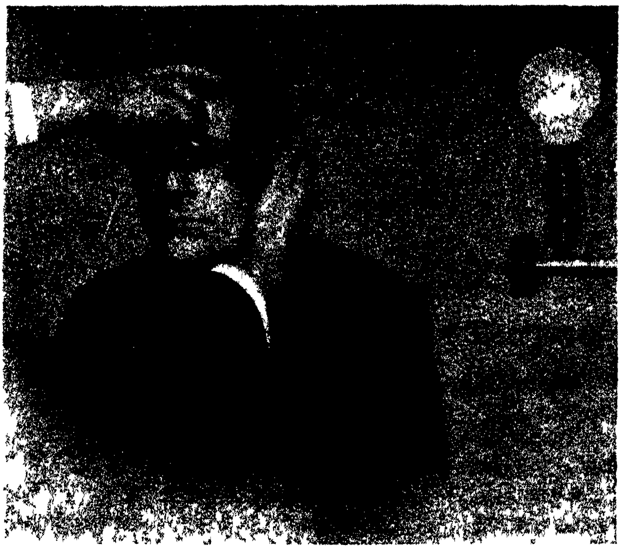
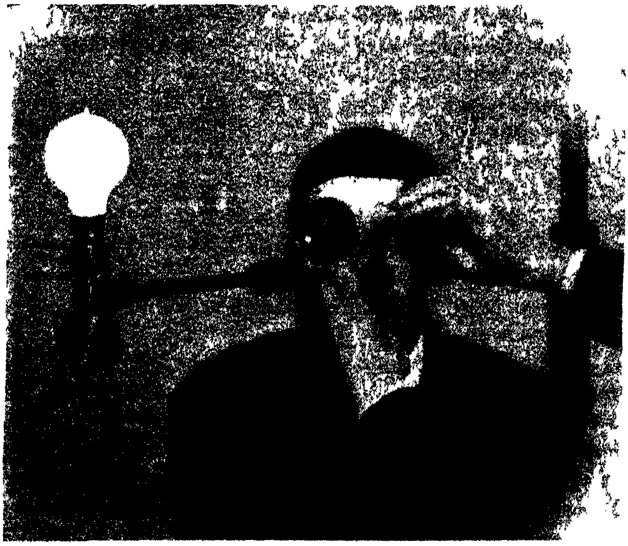


FIG 81. Examination of the eye with the lens and loupe, with the light upon the same side of the patient's head.



G 82. Examination with the lens and loupe, with the light on the opposite side of the patient's head.

The eye, illuminated in this way, is examined by means of a binocular microscope, and much information gained which formerly was unobtainable

The Ophthalmoscope consists essentially of a mirror with a hole in it. The mirror projects a beam of light into the pupil, illuminating the interior of the eyeball. By looking through the hole and along the beam one is enabled to observe the structures rendered visible by it. Elaboration of the above principle has occurred in two directions. A mechanism is provided by which a series of plus and minus lenses can be brought between the observer's eye and the hole in the mirror, permitting, if necessary, the correction of his own and the patient's errors of refraction, rendering the view more perfect, and also enabling him, by using the plus (convex) lenses in gradually increasing strengths, to bring into view structures in front of the retina. To get a clear view of the vitreous crystalline lens iris and cornea it is necessary to place before the hole in the ophthalmoscope mirror about + 6·0 D. + 10·0 D. + 15·0 D. and + 20·0 D. respectively.

Secondly, instead of one, a series of four different mirrors is provided. Of these mirrors the two larger are set in the plane of the instrument, while the two smaller make an angle of 25 degrees with it and can be rotated on their axes. The mirrors are mounted, back to back in pairs, on a rotating plate. The central aperture of either can thus be brought into position when required.

By these means the view of the retina can be varied; either a low power magnification of a considerable area of the fundus oculi or a highly magnified view of a small portion is obtainable, and, further, it is possible to see the fundus details even in highly short-sighted (myopic) eyes. The vitreous can be inspected most satisfactorily for floating opacities and the refractive error of the ocular media can be measured by retinoscopy.

(*a*) Examination by *direct ophthalmoscopy* is suitable for all except very myopic eyes. It should be carried out in the darkened room by artificial illumination and the small concave tilted mirror of the ophthalmoscope, holding the instrument close to the patient's eye. In this method an upright virtual image of the retina is formed behind the eyeball, and it is this which the surgeon observes when looking into the pupil. It is desirable to have the pupils of both eyes dilated (unless this is contraindicated) before giving an opinion on the fundus of either eye.

To examine the patient's right eye the surgeon uses his right eye and holds the ophthalmoscope in his right hand. The tilt of the small concave mirror of the ophthalmoscope should be directed away from the patient's nose and towards the eye to be examined. The light must not be too far from the side of the patient's head or the tilt of the mirror will not be sufficient to allow the light to fall on the eye easily; it must not be too near or the shadow of the patient's head will obscure the lamp, which also may burn him.

In looking through the hole in the ophthalmoscope along the illuminating beam the surgeon must learn not to accommodate for near vision, but to look *through the patient's head*, into the distance behind it. He will then obtain the view of the fundus which he is seeking. If the patient looks straight ahead the surgeon will find the optic disc by looking a little inwards towards the patient's nose. If the patient looks directly into the light seen in the ophthalmoscope mirror the surgeon will find that the beam of light is illuminating the macular region. If the eye to be observed is very myopic its approximate correction can be introduced between the surgeon's eye and the mirror, and by a very near approach to the cornea the fundus can be seen, but the image is so large and the field under observation so small that erroneous conclusions are apt to be drawn and such eyes should be examined by the indirect method.

(*b*) The *indirect method, specially suitable for obtaining a low power view of a* larger area of the fundus and *for* viewing highly myopic eyes, is carried out with the large concave mirror of the ophthalmoscope in combination with the 13 D lens. A real inverted image of the fundus is formed in the air in front of the eyeball, and it is this image which the surgeon observes, magnifying it with the 13 D. lens. The source of light should be above the patient's head.

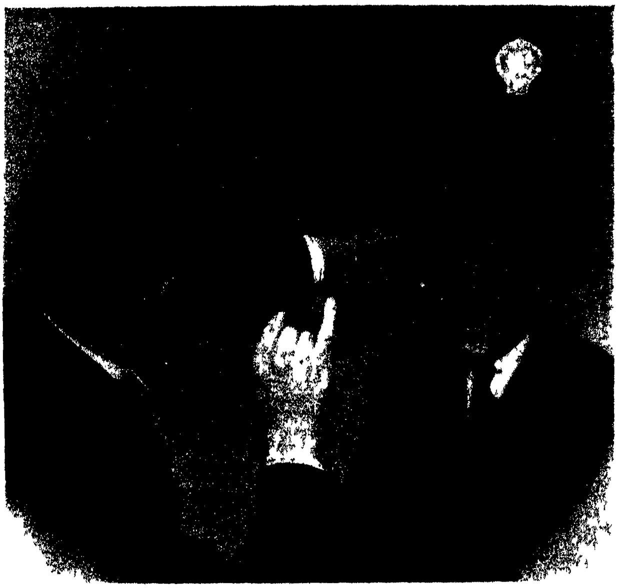


FIG. 83. Ophthalmoscopy—indirect method. Right eye.

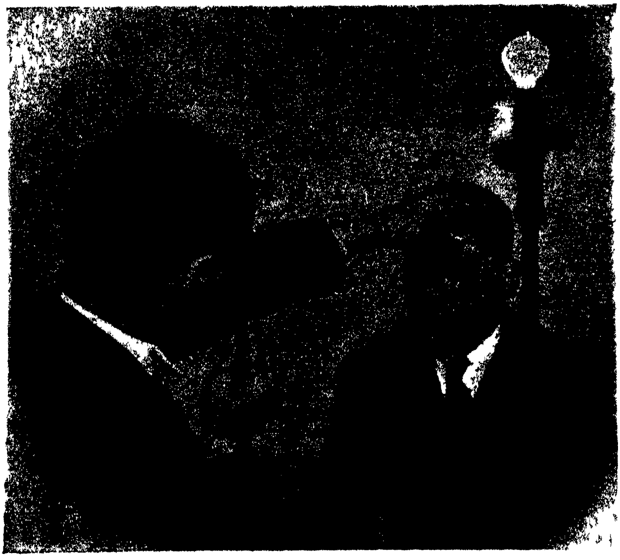


FIG. 84. Ophthalmoscopy—indirect method. Left eye.

The surgeon holds the ophthalmoscope close to his own eye with his right hand and reflects light into the patient's eye by means of the large concave mirror. The 13 D. lens, grasped between the first finger and thumb of his pronated left hand, is held at arm's length immediately before the patient's eye. To examine the right eye the surgeon extends the little finger of his right hand, which is holding the ophthalmoscope with its handle directed horizontally to the right. The patient is instructed to look at the tip of the finger. By this means the optic disc is brought into the retinal field visible to the surgeon without further difficulty. To examine the left eye the surgeon holds the 13 D. lens before it while the patient is instructed to look at the surgeon's left ear. It must be remembered that *the eye which is not being examined must be allowed an uninterrupted view*, otherwise the patient cannot look in the direction in which he is told, and also that the view obtained by indirect ophthalmoscopy is an inverted one.

(*c*) The *small tilted plane mirror*, with which properly constituted ophthalmoscopes are provided, is useful to carry out an examination of the vitreous for floating opacities. The mirror is used exactly as in direct ophthalmoscopy, and behind it are inserted plus lenses of gradually increasing strengths. In this way the vitreous can be brought under observation in successive planes from that just anterior to the retina to one just posterior to the crystalline lens. Any floating opacities in the vitreous are rendered more obvious by movement. If the patient is asked to look quickly "up ... down ... straight in front ..." two or three times in succession while the plus lenses behind the mirror are altered the presence of floating vitreous opacities hardly can pass unobserved. They may be large and not very numerous when they are immediately obvious, or very small and present in the form of a faint cloud when they are much more difficult to see. They may be rendered more visible by arranging matters so that the eye comes to rest after its movements with the optic disc in full view of the surgeon. The bodies can be seen more easily against the whitish background of the disc.

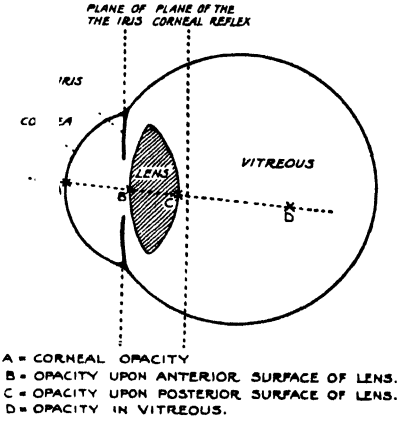

PLANE OF THE IRIS
PLANE OF THE CORNEAL REFLEX
IRIS
VITREOUS
LENS
B
C
D
A = CORNEAL OPACITY
B = OPACITY UPON ANTERIOR SURFACE OF LENS.
C = OPACITY UPON POSTERIOR SURFACE OF LENS.
D = OPACITY IN VITREOUS.

FIG. 85. To illustrate the localisation of opacities.

(*d*) The *large plane mirror* of the ophthalmoscope is used for two distinct purposes :—

Preliminary examination.

Retinoscopy.

I. On commencing to examine the patient with the ophthalmoscope, light should be thrown on the eye from a distance of about a metre, by means of the large plane mirror, from a source of light placed above the patient's head. In the normal eye a " red reflex " is obtained from the fundus which is bright and uniform. If an opacity is present this becomes visible as a black patch in the red reflex wherever in the eyeball the opacity may be situated. An intraocular neoplasm may be visible as a low rounded eminence darkening the reflex in a definite position. A detached retina will show itself by darkening and alteration of the red reflex, and also probably by the presence of large floating opacities seen when the eye moves. A little consideration will enable one *to estimate the position of any opacity* within the eyeball by this method. Ordinary observation teaches that all opacities are referred by the observer to the *plane of the iris*—the first opaque structure which is encountered on looking into the globe. On watching any dark opacities seen against the red reflex when the pupil is dilated the phenomenon of parallax is observed. If the opacity is situated in front of the iris it moves up when the eye looks up. If the opacity is situated on practically the same level as the iris on the anterior surface of the lens it appears in the centre of the pupil in all positions of the eye. If the opacity be behind the level of the iris, in the lens or vitreous, it appears to move down when the eye looks up.

Another guide as to the position of opacities can be obtained from a study of the corneal light reflex. The corneal surface can be considered as a convex mirror giving a reduced erect virtual image behind its surface of any object capable of reflection in it. This image is situated from 4 to 5 mm. behind its anterior reflecting surface. The radius of curvature of the cornea is 9½ mm. The small bright corneal light reflex " covers " the centre of curvature of the cornea in all positions of the eyeball, and may be considered as emanating from that point. It is to be noticed that this light reflex always appears to move in a contrary direction to that in which the eye is moved. Considering the measurements of the globe, the cornea is about 1 mm. thick, the anterior chamber is about 4 mm. deep, and the anteroposterior diameter of the lens also measures about 4 mm. Hence the posterior pole of the lens and the corneal light reflex appear to be situated at the same depth, namely, at 9 mm. from the anterior surface of the cornea and 4 mm. behind the plane of the iris. When the eye is moved any opacity also will exhibit the phenomenon of parallax with reference to the corneal light reflex. If the opacity is in front of the *plane of the corneal light reflex* it will appear to move up with reference to the corneal reflex when the eye moves up. If the opacity is in the plane of the reflex (namely, at the posterior pole of the lens) it will maintain its relation to it in all positions of the eyeball, while if the opacity is behind the plane of the corneal light reflex (namely, in the vitreous) it will appear to move down with reference to it when the eyeball moves up.

Combining the information given by parallax relative to these two planes we arrive at the following:—

Opacities in the cornea and anterior chamber apparently will move up when the eyeball looks up, but the corneal light reflex will move down.

Opacities on the anterior surface of the lens, being in the plane of the iris, will appear not to move from their position when the eye looks up, but the corneal light reflex will move down.

Opacities in the lens will appear to move down when the eye looks up, but will not descend as rapidly as the corneal reflex.

Opacities at the posterior pole of the lens will appear to move down when the eye looks up, but almost will keep pace with and follow the corneal light reflex.

Opacities in the vitreous will appear to descend when the eye looks up, their descent being even more rapid than that of the corneal reflex.

II. *Retinoscopy*. When a beam of light is reflected on to a dilated pupil by means of the plane mirror of the ophthalmoscope held at a distance of a metre from the eye, it is found that movements of this beam elicit corresponding movements of the red retinal reflex which it produces.

If the beam is passed across the pupil from right to left in a hypermetropic eye the red retinal reflex appears to move in the same direction (" with the mirror "). If the same manœuvre is carried out in a myopic eye where the myopia exceeds 1 dioptre, the red retinal reflex will appear to move in the opposite direction (" against the mirror "). By counteracting this tendency

to movement by means of lenses placed before the eye its refraction can be measured and great assistance rendered to the ophthalmic surgeon in the prescription of glasses.

There follows a brief account of retinoscopy with an interpretation of the results obtained but without any scientific explanation of the phenomena observed.

It should be stated at once that in no case should retinoscopy be done without taking the opportunity thus afforded of making a careful note of the condition of the fundus oculi of each side.

The principles involved are extremely simple. The student is advised to read the whole paragraph through without concentrating upon minor points which he may not follow at a first consideration.

Instead of discussing the movements of the red retinal reflex itself, ophthalmic surgeons consider those of the shadow of the pupil margin at the edge of the reflex. When the tendency to movement of this reflex, when the light is swung across the pupil, has been counteracted by lenses the "shadow" is said to have "changed." The results are affected by :—

(*a*) The *midriatic* used : after the pupil has been dilated with Homatropine the ciliary muscle is still in a state of "static" tone although sufficiently paralysed to prevent accommodation for near vision. Cocaine dilates the pupil without even this effect upon the ciliary muscle.

Static tone of the ciliary muscle can be abolished by the use of atropine, and when this midriatic is used "minus one" must be added to the figures obtained to allow for this effect.

(*b*) The *distance* at which the observer's eye is from that of the patient when the results are recorded. If retinoscopy could be carried out at a distance of 6 metres from the patient the results, as they stood, would represent the ocular refraction, but this would be inconvenient and it is customary to do retinoscopy at a distance of 1 metre. Results so obtained can be "adjusted for distance" to those which would have been obtained at 6 metres by the addition of minus one to the figures obtained at 1 metre's distance.

Place the patient, wearing a pair of spectacle frames, in the dark room with the light just above his head so that his eyes are in shadow. Hold the ophthalmoscope in the right hand before the right eye and place the trial case so that the lenses can be conveniently taken in and out with the left hand. Carry out the tests at 1 metre from the patient.

Consider the following four cases :—

Case I. When the *light* (reflected from the lamp by the large plane mirror of the ophthalmoscope) swings across the observed eye horizontally from right to left and vertically up and down the *shadow* is found to move *with* (*i.e.*, in the same direction as) the movements of the light in all directions. Place *plus* lenses before the observed eye until the shadow appears to move *against* (*i.e.*, in the opposite direction from) the movement of the light. Each observer will be found to have a slightly different "end-point" but care must be taken from the first to gain a definite one.

Record the results as in Fig. 86.

That is the shadow changes both horizontally and vertically at the same point, namely, with + 6·0 D. lens in the right and + 4·5 D. lens in the left. Add minus one for distance. Then, when tried at the test types at 6 metres, the patient should read—

Right eye with + 5·0 dioptre spherical lens vision = 6/6.

Left eye with + 3·5 dioptre spherical lens vision = 6/6.

Note that in such a case of high hypermetropia the more highly hypermetropic eye is likely to be amblyopic and see less than 6/6.

A note of the fundi and media should be made between the retinoscopy results at the time of this examination. Its absence will serve to remind the observer that this opportunity of examining the patient's fundi and media has been missed.

Case II. When the light swings across the observed eye horizontally and vertically the shadow is found to move *against* the light in all directions.

Place *minus* lenses before the observed eye until the shadow appears to move *with* the light.

Record the results as in Fig. 86.

That is the shadow changes with a −6·0 D. lens in the right and a −4·5 D. lens in the left eye. Add minus one for distance.

Then, when tried before the test types, the patient should read :—
Right eye with −7·0 dioptre spherical lens vision = 6/6.
Left eye with −5·5 dioptre spherical lens vision = 6/6.

Note that in the case of high myopia the more myopic eye is likely not to read 6/6 on account of the considerable reduction in the size of the image seen with that eye through the high myopic lens.

The shadow may not always change at the same figure in all directions. Sometimes one may even move *with* the light and the other *against* it, requiring a plus and a minus lens respectively to change them. And, further, the shadow may not move vertically but at an angle, perhaps up and out and down and in, while the other axis lies at right angles to it. It is only in irregular astigmatism (like that caused by corneal scarring) that the axes are not at right angles and in such a case the error cannot be corrected by glasses. When the difference between the figures is great the tilt of the axes can easily be estimated to 15°, the notation being from left to right, anticlockwise from 0° to 180° D., in each eye.

Case III. When the light swings across the observed eye the shadow is found to move *not* horizontally but vertically, and, further, to require a different lens to reverse its direction in the two axes.

Record the results as in Fig. 86.

Now the *difference* between the figures in the two axes represents the amount of the *astigmatism* so that in this case there is 1·5 D. of astigmatism corrected by a cylindrical lens of that strength. The *sign* of the cylinder depends upon which axis is used as a base line from which to calculate the prescription, so that correcting (1) on the more horizontal axis as a base line, adding minus one for distance, the patient on the test type should read :—

R.E. with + 3·5 D. sph. + 1·5 D. cyl. ↙ 30° V = 6/6
L.E. with + 5·0 D. sph. − 1·5 D. cyl. ↘ 135° V = 6/6,

or (2) on the more vertical axis as a base line, and adding minus one for distance :—

R.E. with + 5·0 D. sph. − 1·5 D. cyl. ↘ 120° V = 6/6
L.E. with + 3·5 D. sph. + 1·5 D. cyl. ↙ 45° V = 6/6.

A little consideration, or, better, actually handling the lenses, will show that these two prescriptions are identical.

When the readings are small and near unity it is sometimes a little difficult to see by what means the ultimate results have been obtained.

Case IV. When the light swings across the observed eye the shadow is found not to be very defined and to change quite soon at or near unity.

Record the results as in Fig. 86.

The astigmatism as given by the difference between the measurements of the two axes in the right eye is 1·25 dioptres, and by the difference in the measurements of the axes in the left 0·5 dioptres. This will represent the *strength* of the cylinder necessary to correct it in each eye respectively.

The *sign* of the cylinder will depend upon which axis is used as a base line from

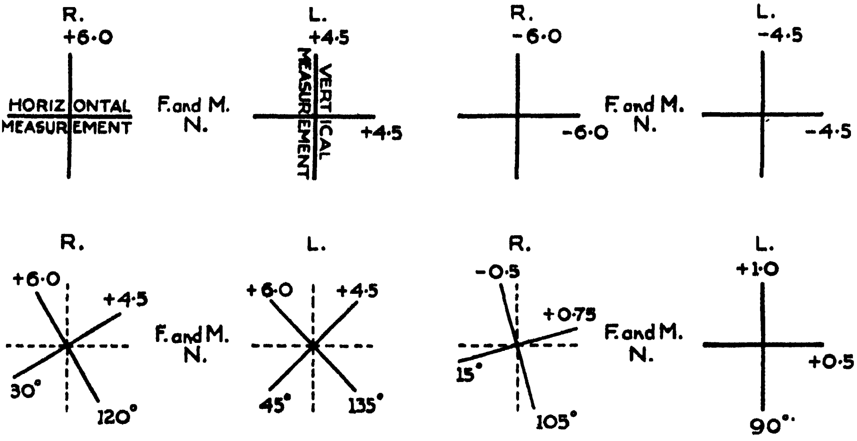


Fig. 86.

which to calculate the prescription. Adding minus one for distance, the patient upon the test types at 6 metres will read :—

Correcting (1) on the more horizontal axis :—

R.E. with −0·25 D. sph. −1·25 D. cyl. ↙ 15° V = 6/6
L.E. with −0·5 D. sph. + 0·5 D. cyl. → 180° V = 6/6,

or (2) on the more vertical axis :—

R.E. with −1·5 D. sph. + 1·25 D. cyl. ↘ 105° V = 6/6
L.E. with −0·5 D. cyl. ↓ 90° V = 6/6.

These two prescriptions being identical.

It remains to discuss the question of the paralysis of accommodation.

The elasticity of the crystalline lens, as has been said, is greatest in infancy, being then about 20 dioptres, but begins to fail at once, rapidly at first, and continues to do so, at a decreasing rate, throughout life. At forty years of age the power of accommodation is 4 dioptres and the patient, if emmetropic, can read small print at ¼ metre (25 cm.). From then onwards the rate of failure may be taken to *average* 0·75 dioptres for every five years (*i.e.*, at forty-five years one adds +0·75 D. sph. for presbyopia, at fifty + 1·5 D. sph., at fifty-five +2·25 D. sph., at sixty +3·0 D. sph.). These figures should be taken only as an indication of the *maximum* amount to be added. It must be remembered that presbyopia must never be over-corrected or the power of convergence, which is intimately linked with it as a synergic act, will be disturbed. It is wise never to add more than + 3·0 D. sph. for presbyopia even if the patient is much over sixty years of age, thus leaving some accommodation to stimulate convergence. If for any reason more is found to be usefully added, *prisms with their bases in* up to 3 prism dioptre strength may be added before each eye combined with the addition to aid the converging effort and allow the patient to read with the book held closer to his eyes than the standard 25 cm.

It follows that it is in the case of highly hypermetropic children that spasm of accommodation will occur, rendering the results of retinoscopy misleading. Here it will be wiser to use atropine ointment for four days four times a day beforehand to make sure that the static tone of the ciliary muscle is paralysed. This must be allowed for by the addition of " minus one for atropine " to the retinoscopic results in addition to the " minus one for distance " usually added before prescribing glasses. As a matter of practice it is found that spasm of accommodation is most apt to occur in the intermediate degrees of hypermetropia and it is customary to " *add minus one for atropine* " in adjusting retinoscopic shadows of from +1·0 D. to +3·0 D., to " *add minus two for atropine* " in adjusting shadows of between +3·0 D. and +6·0 D., and to " *add minus one for atropine* " in adjusting shadows of from +6·0 D. to + 9·0 D., but these details are rapidly learnt by experience.

The effect of atropine on the ciliary muscle lasts about ten days and clearly it should never be ordered in young adults who are earning their own living at any clerical occupation. Homatropine and cocaine (2 per cent. of each) should be substituted, care being taken that the patient is tested for near vision before it is put in. When making up solutions of drops in castor oil for retinoscopy the *alkaloid* itself is always used as its salt is insoluble in oil. If homatropine and cocaine is used its effect should always be counteracted by eserine (½ per cent.). Stronger solutions of eserine may cause spasm of accommodation and strong pupillary contraction, causing a good deal of pain and dimness of vision.

If patients are over forty years of age care must be exercised before any midriatic is instilled at all. Always examine the fundus first for any cupping of the disc. A history of glaucoma symptoms will at once exclude its use, and its effect must always be thoroughly counteracted with a miotic. If in any doubt use a watery 1 per cent. solution of homatropine, this is more easily counteracted, or even cocaine alone. The author has seen a middle-aged patient, who attended an outpatient department for glasses, have a midriatic instilled and leave the hospital without having it counteracted. Later in the day she returned with well-marked double acute glaucoma and had to be admitted immediately and surgically treated for the condition.

Many patients over forty years of age who have never had any trouble with their eyes before, nor even glasses, often come merely for correction of their advancing presbyopia, which can be done easily without any midriatic at all, but it is just in these cases that an examination of the fundus is so important as revealing early evidence of cardio-vascular disease, glaucoma, etc., quite unsuspected by the patient. If he does not easily read 6/6 and Jaeger 1 with each eye the greatest care should be taken to discover why he fails to do so.

It is often quite easy to do a retinoscopy in elderly people without any midriatic, especially if this is carried out as a control to careful subjective testing. And this use of retinoscopy without a midriatic as a control to careful subjective testing is capable of much wider use than that at present made of it.

Ocular Movements. During external examination of the eyes with the lens and loupe, the relative positions of the two eyes and their power of movement should be first investigated.

I. Does the patient squint (*i.e.*, are the visual axes parallel), and if so does he complain of diplopia (double vision) ?

II. Can the eyes be moved together in all directions or are the movements of one or both in any way limited ?

III. Are any abnormal movements present in one or both eyes ? Abnormal movements are difficult to discover, and may vary from day to day. Their presence is frequently of pathological significance.

Movements of a jerky character (**nystagmus**) may be present in one or both eyes and be more marked when the eye is turned in some particular direction. The nystagmus may be lateral or vertical, or even rotatory in character. If rotatory the movements in the two eyes tend to correspond, being clockwise in one and anticlockwise in the other.

Nystagmus occurs in a wide variety of conditions. In cases of cerebellar tumour it is said to be fine and quick on looking away from the side of the tumour, but coarse and slow on looking towards it. As an early sign of disseminated sclerosis, nystagmus may be completely absent on some occasions, while well marked at others. Miners and those who work under bad conditions of illumination frequently exhibit nystagmus. Opacities in the ocular media (congenital or acquired) may give rise to nystagmus, and in these cases it is often unilateral. Albinos and those in whom the macular region is not properly differentiated also show nystagmoid movements. In the case of albinos the nystagmus and the albinoid condition often become rectified to a considerable extent with advancing years.

Lastly, it is seen when a normal individual is viewing rapidly moving objects, as in the case of a traveller looking out of the window of a rapidly moving train. Here nystagmus may be considered as physiological. *Nystagmus is never hysterical,* and its presence should put this diagnosis out of court at once.

Another abnormal ocular movement—the **skew deviation** of the eyes, seen in cerebellar tumour—is of interest to the surgeon. Here one eye is said to turn down and in and the other up and out, but variations may be present, and as the position occurs only for a moment at a time a careful watch has to be kept for its fleeting appearance.

Lastly, certain abnormal movements of a different character may be mentioned. On making the patient look sharply to the right and left, up and down, the iris appears to "shake" (*iridodonesis*). Whatever may be the cause of this it is evidence of the absence of the crystalline lens from its normal position behind the iris, where it steadies and supports this structure. This piece of information obtained early in the examination of the eye may be of the greatest value to the surgeon.

The Pupil Reactions. The reaction of the pupils to light may be direct or consensual.

(*a*) *The direct reaction.* Have the patient near a good source of light and ask him to look in front of him, keeping both eyes open. Both eyes are then obscured by the surgeon's hands. The right one being uncovered, its reaction is observed, the left remaining obscured.

(b) *The consensual reaction* is obtained by shading one eye and alternately shading and exposing the other. It is found that the pupil of the shaded eye, as well as of the exposed, contracts to the light stimulus.

This contraction is a true reflex carried out through a constrictor centre only, the nervous path being such that when intact a reaction in both eyes is effected by light falling upon one retina.

Afferent fibres pass from the retina along the optic nerve to the chiasma, where a decussation takes place. Above this point fibres from each eye travel by both optic tracts to both anterior corpora quadrigemina. Fibres of this reflex arc for constriction of the pupils to light do not ascend above this level and make no communication with the external geniculate bodies. The fibres now pass downwards along the posterior longitudinal bundle to the anterior parts of the third nucleus. The efferent path of the reflex is along the oculomotor nerve, and the branch to the inferior oblique muscle. Thence by its motor root to the ciliary ganglion and by the short ciliary branches of this body to the constrictor pupillæ of the iris.

Evidence for the above rests upon clinical facts under normal and pathological conditions. In *a lesion of one optic nerve below the chiasma* (producing blindness of one eye) the consensual reaction of the pupil of the blind eye to light can be obtained, although its direct reaction to light is lost. The efferent path from the third nucleus remains intact, although the afferent path from the blind eye to the nucleus is destroyed. In *a lesion of one optic tract above the chiasma* (producing homonymous hemianopia) corresponding halves of the retinæ become blind. Light thrown upon the blind half of one retina produces no contraction of either pupil, but light thrown upon the normal half of either retina produces contraction of both pupils (*Wernicke's pupil reaction*). This is accounted for by supposing a decussation of the afferent fibres of the light reflex to occur at the chiasma.

In contradistinction to the above, *constriction of the pupils to accommodation is not a reflex*, but one of a series of co-ordinated muscle actions consisting of constriction of the pupils, convergence of the visual axes and contraction of the ciliary muscles. This synergic action originates with the idea of near vision in the cerebral cortex. Pupillary constriction on accommodation is tested by asking the patient to look first into the distance and then at the surgeon's finger held at about 10 inches before his eyes. The descending nerve paths from the Rolandic area to the eye muscles which carry out the synergic act of accommodation lie through the posterior parts of the internal capsules to the external geniculate bodies and optic thalami and hence to the third nuclei along the posterior longitudinal bundles. It is to be noted that this path does not pass through the anterior corpora quadrigemina, the special path for the light reflex.

The constriction of the pupils to accommodation, not being a reflex, is retained in diseases such as tabes, in which reflexes of all types tend to be diminished or lost. The connection of the direct path from the cortex through the geniculates and optic thalami to the third nuclei remains intact, while lesions in the neighbourhood of the anterior corpora quadrigemina or their connections with the third nuclei tend to destroy the light reflex arc. The lesion is not in the optic tract or nerve, because sight remains good without hemianopia or other physical sign pointing to their involvement.

Loss of the pupil reaction to light, while contraction to accommodation is retained, is known as the "**Argyll-Robertson pupil.**" The anatomical explanation suggests that it is much more marked on one side than the other. The lesion which produces the condition is thought to be a chronic inflammation of the ependyma of the posterior part of the third ventricle and the "iter," producing a gummatous fibrosis of the region of the corpora quadrigemina and the posterior longitudinal bundle. It may be added that cases of tabes with Charcot's arthropathy may be found whose pupil reactions to light are normal on one side at least. Constriction of the pupil should be recorded as being absent, sluggish or brisk, and it should be observed whether it is "maintained," that is, if after preliminary contraction the pupil gradually dilates once more. A normal reaction of the pupil to light which is not maintained is seen in cases of retrobulbar neuritis, toxic amblyopia, and disseminated sclerosis. Certain unusual pupil reactions are of interest to the surgeon. In cases of cerebral irritation following concussion the pupil dilates when light shines upon the eye. This is not a reaction of the pupil to light, but of the whole patient to any stimulus, and results from the irritated condition of his cerebral cortex.

Lesions of the sympathetic nerve trunk in the neck, near the apex of the lung or in the region of the first and second dorsal vertebræ, will produce an inactive pupil upon one side, while the opposite pupil will show normal reactions. If the sympathetic trunk is irritated, dilatation of the pupil, with exophthalmos and a retracted eyelid, will be found; if paralysed, pupillary contraction, with enophthalmos and ptosis. The condition can be diagnosed by the instillation of cocaine, which stimulates the sympathetic pupillary dilator fibres upon the healthy side, while on the side of the lesion it has no effect.

Rhythmical dilatation and contraction of the pupils—a condition of **hippus**—is sometimes seen. This has no pathological significance.

The Size of the Pupils. Apart from the pupil reactions, their size and inequality upon the two sides is of importance to the surgeon.

The pupil reactions of intracranial hæmorrhage following injury are important to recognise. As the blood is poured out the pupillary centres are first stimulated and the pupil constricts. If the intracranial hæmorrhage continues the pupil commences to dilate and finally becomes widely dilated; in all stages the pupil is sluggish in its reaction to light. These changes proceed upon both sides, but one side is characteristically in advance of the other, thus giving a clue to the side on which the hæmorrhage is occurring. It must not be forgotten, however, that if the optic nerve is injured in a fracture of the skull, which possibly caused the intracranial hæmorrhage, the pupil upon that side may be widely dilated and inactive from the first (see p. 22).

The size of the pupils in tabes varies upon the two sides, and they are small, frequently irregular in shape and eccentric as to their position in the iris.

The commonest cause of slightly increased size and sluggishness of reaction to light in the case of one pupil is, however, not tabes but trauma. This is frequently overlooked. A direct blow upon the eye may produce rupture of a few of the constrictor fibres of the iris, and hence permanent increase in size of the pupil and a sluggish contraction as compared with the opposite side.

Other local causes in the eye itself also must be remembered. The effect of drugs—atropine and cocaine to dilate and eserine to constrict the pupils—adhesions of the iris to the anterior surface of the lens (synechiæ, iritis) will render the pupil inactive, and finally a blind eye may have a dilated and inactive pupil. Marked difference between the size and reactions of the pupils suggest local causes which should be excluded before lesions of the central nervous system are considered to account for them.

The Intraocular Tension. To examine this the surgeon should support his two hands with the second, third and fourth fingers resting on the patient's forehead, while with the two first fingers he presses alternately upon the globe as if testing for "fluctuation." The tensions of both eyes should be examined and compared. In time the surgeon comes to recognise a normal tension (recorded as T.n.). If this is raised the plus sign is used, if lowered the minus sign. The figure 1 is used if departure from the normal is slight, if marked the figure 2, while the figure 3 describes a degree of tension in which fluctuation is scarcely perceptible (glaucoma), or which gives the non-resistant sensation of a shrinking or perforated globe. The above method, although useful, is not scientific, and "the Schiotz tenometer" has been introduced to render the reading accurate and eliminate the personal factor. Its readings, however, must be controlled constantly by clinical findings, nor is its use entirely free from risk to the patient. It is specially useful to record the difference in tension between the two eyes.

THE LACRIMAL APPARATUS

The tears are conveyed from the conjunctival sac to the nose by means of the tear passages. These consist of several component parts. The openings into the conjunctival sac ("*puncta lacrimalis*") are very small and are situated, one in each lid, a few millimetres from the inner canthus. The puncta should be kept gently in contact with the bulbar conjunctiva by the normal tension of the orbicularis palpebrarum. Upon this contact depends the efficiency of the apparatus. The canaliculi (two capillary tubes) lead from the puncta into the lacrimal sac, each having a slightly curved course of a few millimetres along the most medial portion of the lid margins. The lacrimal sac (the reservoir for tears flowing from the conjunctival sac) is encircled by some special fibres of the orbicularis, and blinking movements of the lids produce in it a negative pressure, and so draw fluid along the canaliculi. When the negative pressure is relaxed on opening the lids, the tears, taking the line of least resistance, flow down the lacrimal duct, which passes through the groove in the lacrimal bone and between the maxilla and the inferior turbinate into the lower meatus of the nose in a direction downwards, forwards and outwards. A valve in this passage prevents tears being sucked back into the lacrimal sac when a negative pressure occurs in it.

Lacrimal Obstruction. If the apparatus works efficiently the lacrimal sac is not distended with tears. If, however, an obstruction occurs between the sac and the nose—its usual site—the tears cannot pass, and a swelling occurs in this situation between the eye and the nose, occasionally with a groove across it, due to the fact that the sac lies behind the internal tarsal ligament, giving attachment to the fibres of the orbicularis. This swelling can be diagnosed at once if the fluid it contains can be made to regurgitate through the puncta into the conjunctival sac. The facts that no regurgitation takes place on pressure over the lacrimal sac and that no swelling is present in this situation are presumptive evidence that the lacrimal apparatus is working normally. Other swellings occur in this situation, such as a distended ethmoidal cell and a Meibomian cyst very near the inner canthus and the best evidence that the lacrimal sac is not involved is provided by the passage of a syringe along the canaliculus into the sac and being able to direct a stream of fluid into the nose.

If the lower part of the lacrimal duct becomes impassable the patient must express carefully all the material collected in the lacrimal sac by regurgitation at frequent intervals. As long as this can be done there is no immediate danger, but if owing to chronic inflammation the canaliculi also become impassable, a **lacrimal abscess** is almost certain to occur and must be opened by incision into the sac, followed later by the removal of this now useless area of mucous membrane. When this is done, as much of the nasal duct as possible must be taken away, and it is well gently to scrape the canal along which it passes with a Volkmann's spoon.

Epiphora is a condition in which there need be no excess of normal secretion of tears, but, owing to the inefficient working of the lacrimal apparatus, the tears overflow the lid margins and course down the patient's cheeks on the slightest provocation.

Lacrimation, on the other hand, results from excessive secretion of tears, which are poured out too quickly to be drained away by even a perfectly functioning lacrimal apparatus. Such a condition may be physiological or be due to irritation, caused by the presence of a foreign body in the conjunctival sac, or the result of deep-seated disease in the eyeball.

Normally the flow of tears is just sufficient to lubricate the conjunctival sac and counterbalance the effects of evaporation. It is not normal for a stream of fluid to be constantly passing down the lacrimal passages.

Lacrimal obstruction may be treated by the passage of graduated probes, preceded if necessary by the dilatation of the punctum lacrimalis and canaliculus. In this instance a narrow thin-walled tube lies in a bony canal, and the possibilities of crushing the delicate mucous membrane between the probe and the rigid canal are great.

Chronic Dacryocystitis—inflammation of the lacrimal sac—may result from tuberculous or gummatous infiltration of the tissues, and it has been thought that lupus of the face has reached this site from the nasal mucous membrane by infection via the lacrimal passages.

THE LIDS AND CONJUNCTIVÆ

The structure of the eyelids is built upon a fascial expansion which is attached peripherally to the margins of the orbit, while centrally the palpebral fissure forms an elliptical gap in it. Attached to the margins of the gap are the upper and lower tarsal plates—fibrous thickenings of the fascia—which form as it were the skeletons of the lids but contain no bone or cartilage cells. The unions of the two eyelids which occur laterally and medially are known as the outer and inner canthi. External to the palpebral fascia are the skin and the orbicularis palpebrarum. Deep to it and the tarsal plates is the conjunctiva covering the inner surface of the lids. Into the upper lid also enters the levator palpebræ superioris muscle which is inserted by fibrous bands into the skin, the upper margin of the tarsal plate, and the upper conjunctival fornix (a threefold insertion). **The conjunctival membrane** lines the inner surfaces of the upper and lower lids and is reflected from thence as a covering for the front of the globe (conjunctival fornix). It is somewhat firmly attached to the tarsal plates, but only loosely to the eyeball, by connective tissue, so that considerable amounts of fluid or inflammatory exudate may collect in the subconjunctival spaces. Œdema in this region is known as *chemosis.*

At its reflection from the lids on to the globe the conjunctiva comes into relation with Tenon's capsule at the fornices. By incising and turning the conjunctiva back from the corneal margin and holding it away from the globe the anterior limit of Tenon's capsule is put upon the stretch, and if the separation is carried farther back the capsule is opened by the dissecting scissors. This method of opening this capsule is employed to reach the tendons of the six extraocular muscles at operation. The bellies of these muscles lie external to Tenon's capsule, but the tendons pierce the capsule by specially constructed openings and are intracapsular. The conjunctiva is firmly attached to the corneal margin, and is continued over it as a transparent layer (Bowman's membrane), forming the superficial corneal epithelium. When the lids are closed the conjunctival membrane forms in front of the eyeball a complete sac, the interior of which is continuous with the lower meatus of the nose by means of the mucous membrane of the lacrimal apparatus. The conjunctiva may be infected directly from the air or by matter carried to it by the fingers, or indirectly from the lacrimal sac or nasal epithelium.

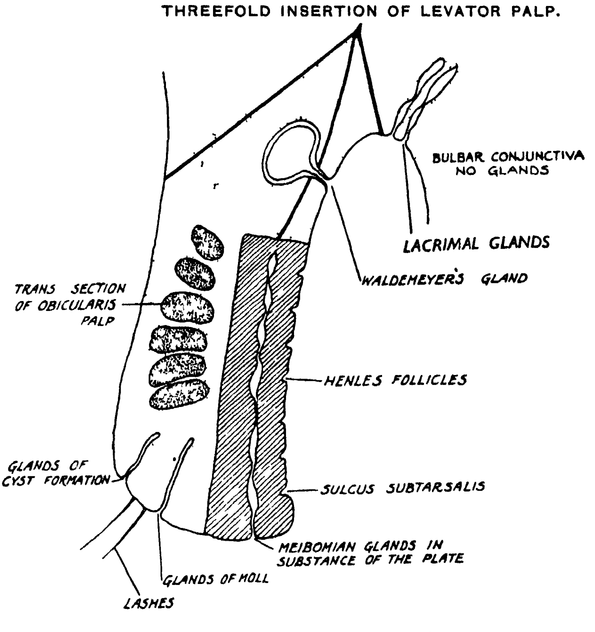

THREEFOLD INSERTION OF LEVATOR PALP.
BULBAR CONJUNCTIVA NO GLANDS
LACRIMAL GLANDS
WALDEMEYER'S GLAND
TRANS SECTION OF OBICULARIS PALP
HENLES FOLLICLES
GLANDS OF CYST FORMATION
SULCUS SUBTARSALIS
MEIBOMIAN GLANDS IN SUBSTANCE OF THE PLATE
GLANDS OF MOLL
LASHES

FIG 87. To illustrate the glands of the palpebral conjunctiva.

The palpebral conjunctiva in association with the lids is supplied with glands; the bulbar portion in relation with the globe contains no glands. The lacrimal glands open by fifteen to twenty ducts into the upper fornix, while near the lid margins are three gland openings, two connected with the eyelash follicles and one behind these on the edge of the lid itself. Those in connection with the eyelash follicles are:—

(1) Those of Moll, which when inflamed cause the common "stye."

(2) Those which enlarge to form small translucent cysts seen at the outer edges of the lids.

(3) Behind the line of lashes on the margin of the lid will be found the openings of the **Meibomian glands**—thirty in number, secreting sebaceous material—which occupy the depths of the tarsal plates. These glands form

cysts, which present upon the inner aspect of the plate, but when large are also visible upon the outer surface of the lid.

On the inner surface of the tarsal plate are the conjunctival follicles of Henle, concretions in which give rise to considerable corneal irritation.

Between the follicles of Henle and the lacrimal gland are to be found the glands of Waldemeyer, occasionally giving rise to endotheliomata and cysts, some of which contain black fluid altered blood.

To Evert the Upper Lid. The surgeon stands *behind* his patient, who is seated, and asks him to look down while with his thumb he pushes the upper lid gently down over the lower. By this manœuvre the edge of the upper lid " rides up " a little, and can be taken gently between the finger and thumb and turned back without inflicting discomfort.

DISEASES OF THE EYELIDS

Blepharitis. Inflammation of the lids is an extremely disfiguring and intractable condition, yet often of long standing before treatment is sought. The fact that the causal organisms are buried in the ducts of the glands along the margin of the lid probably explains this. The mouths of these ducts are further sealed by crusts, which prevent both the escape of discharge and the effective action of remedies which may be diligently applied.

Treatment (*a*) Local. This consists in aiding the removal of the crusts by bathing the lids in a lotion of sodium bicarbonate (1 per cent.). After this an ointment of ammoniated or yellow oxide of mercury may be rubbed in gently. (It is to be noted the sodium bicarbonate is not good for corneal epithelium.)

(*b*) General treatment. Blepharitis is intimately associated with squalor and malnutrition. The ears, teeth and nasopharynx should be put in a satisfactory condition and care taken to see that the hair is clean and brushed back from the eyes. Lastly, the patient should be refracted and given, if necessary, the appropriate glasses.

Stye (External Hordeolum). An infection of one of the glands in connection with the eyelashes must be treated by simple incision and evacuation of the pus, which is preferable to pulling out the lash. Repeated styes indicate a poor condition of general health or point to the need of glasses. Their frequent occurrence can be much reduced and often aborted by bathing the eyes with warm boracic lotion two or three times a day regularly, whether a stye is present or not.

Meibomian Cyst (Internal Hordeolum) must be treated by incision and curetting The walls of these cysts are often thick and remain visible long after their contents have been evacuated. The cysts usually contain a gelatinous fluid, which becomes softer as they increase in size. They may contain pus. The surgeon should stand behind the patient, who should be seated. The lid is everted and the cyst held in a pair of Meibomian forceps. The incision is made at right angles to the long axis of the tarsal plate upon its conjunctival surface with a Beer's knife. The interior of the cyst is evacuated through the incision with a small sharp spoon. The operation can be performed easily under cocaine (4 per cent.), and adrenaline (1 in 1000). The patient should be dismissed with boracic lotion (2 per cent.) and with his eye bandaged. When the effect of the cocaine has passed, the edges of the wound in the tarsal plate will rub against the cornea and give rise to much pain unless the lid is immobilised. The bandage can be left off after twenty-four hours. The lining epithelium of these cysts may grow through an opening in them and form a sebaceous granuloma. This can be cut away with scissors and the cyst from which it springs evacuated in the ordinary way.

Three **deformities of the lids** may be mentioned:—

Entropion, usually the result of irritation and spasm of the orbicularis muscle. By the rolling inwards of the lid the lashes are turned against the conjunctiva or cornea (trichiasis) and a conjunctivitis or corneal ulceration results.

Ectropion, the result of cicatricial contraction of the lid or atrophy of the orbicularis (by the normal tone of which the lid is kept in contact with the globe). The lid begins to turn outwards. The relations of the puncta with the bulbar conjunctiva are thus disturbed and epiphora and chronic conjunctivitis results.

Symblepharon, the adhesion of the bulbar and palpebral conjunctivæ, is usually the result of burns, but may follow wounds and ulceration. It is also a complication of pemphigus of the conjunctiva.

The treatment of these conditions consists in small plastic operations.

Two unusual conditions of the lid are of interest to the general surgeon and form favourite " cases " by which to test the mental agility of students. They should be remembered—Primary Chancre (see Vol. I.) and Vaccinia.

DISEASES OF THE CONJUNCTIVA

Conjunctivitis. Inflammation of the conjunctivæ and deep structures of the eyeball is shown by increased congestion of this thin membrane. The vascularity is of various types.

(*a*) **Localised redness** suggests a foreign body. If near the outer canthus, the body may be tucked away in the conjunctival folds in this region. A misplaced lash will cause a patch of localised redness. An eyelash in the punctum gives a congested conjunctival patch near the inner canthus or this may be due to inflammation in the neighbouring lacrimal sac.

Foreign Body. The search for this should not be abandoned until the upper lid has been everted and the conjunctival surface of the tarsal plate inspected. If the typical "pricking" sensation persists, a drop of fluorescein (1 per cent.) instilled will help to locate some foreign body, such as a piece of glass or cotton, which may be difficult to see or it may reveal a small corneal abrasion. Fluorescein staining is seen more easily by daylight than by artificial illumination.

In localised redness of the underlying sclera (*scleritis*) the patch consists of smaller vessels set in a closer network and of a purple colour, from which the blood cannot be expressed by gentle pressure through the overlying lid as can be done in conjunctivitis. The patch is also frequently raised in a slightly marked oval swelling due to scleral œdema and very tender.

Should the redness be distinctly circumcorneal, some inflammation of this structure or of the underlying iris or ciliary body should be suspected.

Glaucoma gives rise to a condition of distension of the circumcorneal *veins*, which at first sight it is sometimes difficult to distinguish from a conjunctivitis.

Inflammation of the conjunctival sac as a whole may be unilateral or bilateral, and is characterised by the signs of " redness, swelling, heat and pain."

Redness affects the whole of the palpebral and bulbar conjunctiva.

Swelling of the conjunctiva—chemosis—may be so marked that the lids cannot be closed efficiently.

Heat: The temperature of the surrounding area is raised and the patient complains of burning pain accompanied by a gritty sensation of the eyes.

Profuse lacrimation and avoidance of exposure to light (photophobia) make vision difficult.

The *general treatment* of conjunctivitis consists of frequent irrigation with warm boracic lotion used in an " undine " with Fisher's tray. This is followed by the application of boracic ointment (1 per cent.) to the lids to prevent their sticking together and preventing the escape of discharge. No case of uncomplicated conjunctivitis should be bandaged. If photophobia is marked, a shade should be provided for both eyes to keep off the light but not obscure vision.

For the more severe cases antiseptics may be used :—

(1) Mercuric chloride lotion of not more than 1 in 6,000 strength.

(2) A fluid preparation of a silver salt, the best being a solution of silver nitrate (1 per cent. or 2 per cent.) painted on the everted lids. *The solid " silver stick " and lotions containing lead should find no place in the ophthalmic department.*

(3) Zinc sulphate in aqueous solution (gr. ½ ad ℥i), specially useful for angular conjunctivitis.

(4) Copper sulphate as " drops " (in 1 per cent. strength or less) or in the solid form as " blue stone stick," used in the treatment of trachoma.

Sterilisation of the conjunctival sac is impossible owing to bacteria becoming embedded in the conjunctival membrane. Solutions of silver nitrate partially overcome this difficulty by producing a superficial conjunctival slough which can be removed by irrigation, carrying off many organisms with it. Silver must not be used as a conjunctival antiseptic for long periods, or staining will result (argyrosis).

Varieties of Conjunctivitis. (*a*) **Catarrhal conjunctivitis** may follow the presence of a foreign body or be conveyed by the fingers. The conjunctivæ may also be infected from the lids or lacrimal sac. Catarrhal conjunctivitis is present in the early stages of many acute specific fevers.

(*b*) **Angular conjunctivitis** is due to infection with Morax-Axenfeld's bacillus. The regions of the inner and outer canthi are chiefly affected and the condition tends to run a chronic course. Zinc sulphate is specially useful in its treatment.

(*c*) **Mucopurulent conjunctivitis**, due to Koch-Week's bacillus, is an acute (almost epidemic) infection. Copious mucopurulent discharge occurs from the congested conjunctiva, which soon shows chemosis, and subconjunctival hæmorrhages may appear. Lacrimation and photophobia are intense. The second eye most often becomes infected. Treatment with irrigations and painting with silver nitrate usually produce rapid improvement and the condition subsides, leaving no ill effects.

(*d*) **Purulent conjunctivitis** occurs in two types, that seen in the adult and that of the newborn infant. It is due to infection of the conjunctival sac, but not necessarily with the gonococcus. The course of the disease and its treatment vary in the two types.

(1) *In the newborn infant* (**Ophthalmia neonatorum**) infection of the conjunctival sac occurs at or immediately after birth. On the third or fourth

day one or both eyes are not opened. The lids are red and swollen and obvious purulent discharge shows itself on the eyelashes. The lids must be separated with great care, to irrigate the conjunctiva and examine the cornea. Injury to the cornea must be avoided, but this structure must be seen properly and kept under observation until the eye is cured. Involvement of the cornea is specially liable to occur in this infection. Both bulbar and palpebral conjunctivæ become greatly chemosed, and discharge thus may be imprisoned under pressure in contact with the cornea. The centre of the cornea, the part farthest from its blood supply, is liable to become denuded of its epithelium and ulcerated. Finally it may perforate, with the escape of a small pellucid body (the lens), and the sight of the eye be lost. If the lens does not escape, perforation of the ulcer and loss of the aqueous may bring it into contact with the base of the ulcer, and a small white spot will remain afterwards on the anterior lens surface. If treatment is faithfully carried out no corneal ulcer develops in the great majority of cases. Should it do so the pupil must be dilated with atropine. If an ulcer has formed perforation is preceded by the formation of a *Descemetocele.* The deepest and most resistant layer of the cornea (Descemet's membrane) here bulges through the weaker anterior layers and presents as a little dark " bubble " in the centre of the ulcerated area.

Ophthalmia neonatorum is prevented by the avoidance of infection at or after birth, and by the instillation of 1 per cent. watery solution of silver nitrate into the eyes of all babies after birth.

Ophthalmia neonatorum probably accounts for about 90 per cent. of the children who are said to have been " born blind " : 30 per cent. are due to the gonococcus, the rest to *B. coli*, staphylococci, streptococci and other organisms.

(2) *In adults* the course of purulent ophthalmia is complicated nearly always by the formation of a corneal ulcer which frequently perforates, and few cases recover without seriously impaired vision. Protection of the sound eye is, therefore, the first principle of treatment immediately the diagnosis has been made from a stained film preparation of the conjunctival discharge. This is done with a *Buller's shield*, constructed of a watch-glass set in a square of waterproof fabric by means of a fluid rubber solution. The square is applied to the sound eye and secured to the forehead, nose, maxillary, and molar regions, with collodion. At the upper and outer angle an aperture is left into which a piece of rubber tubing is fixed. The shield should remain in place over the sound eye until the affected eye is well, and enables its condition to be observed through the watch-glass. The aperture, with the rubber tubing inserted, allows of evaporation and prevents the glass being obscured by a film of moisture. Frequent and thorough irrigation of the conjunctiva of the affected eye and the painting of the infected membrane with silver nitrate (2 per cent.), preventing at the same time the adherence of the lids by the use of sterile boracic ointment, may prevent the complication of a corneal ulcer, but as soon as the onset of this is suggested by opacity of the corneal epithelium the pupil must be dilated with atropine.

(*e*) **Chronic Conjunctivitis.** Under this heading are included phlyctenular, follicular and granular conjunctivitis. The inflammation does not tend to run a definite course towards cure. When this has been attained there is a distinct tendency to relapse. The general condition of the patient is here very important, especially in the case of children. The nasopharynx, teeth, and hair should be looked at carefully and intestinal disinfection carried out (Hyd. c. Cret. gr. i t.d.s.), followed later by tonic remedies. The home conditions should be improved as much as possible. In the most stubborn cases residence in the country in a convalescent home where this type of case is specially accepted will effect a cure.

(1) *Phlyctenular conjunctivitis* occurs most frequently in ill-nourished children. One or several small inflammatory nodules (phlyctens) occur at the junction of the conjunctiva and cornea (limbus). There is general conjunctival congestion, greatest in the neighbourhood of these nodules. The symptoms of conjunctivitis are often severe and photophobia intense. Unless treatment is instituted at once with success the nodules are accompanied by denudation of corneal epithelium in their neighbourhood, with the formation of corneal ulcers, which spread towards the centre of the cornea. These leave opacity, which is densest where the progress of the ulcer is arrested. Hence it is important that they should be checked before the centre of the cornea is reached or the sight may be seriously damaged. Even when the cornea is not involved the cases respond well to atropine. As soon as the conjunctivitis begins to subside yellow oxide of mercury ointment (1 per cent.) may be used with marked success ; at first, however, it is too irritating and must not be used. If a corneal ulcer has complicated the condition the continued use of yellow oxide of mercury after it has healed may reduce considerably the corneal scarring which has resulted.

(2) *Follicular conjunctivitis* is the usual type of chronic inflammation found in this region from whatever cause. In the lower fornix are numbers of large translucent follicles set in the membrane almost like paving stones. In the upper fornix the follicles are much more scanty and often absent. There is no sign of corneal involvement, but the conjunctiva may be affected to such a degree that chemosis is present. These follicles are seen (*a*) as a chronic condition in debilitated persons who live under bad conditions of life ; (*b*) as a subacute involvement, specially in the spring, due to irritation of the conjunctiva by pollen ; in this type the conjunctiva has a milky appearance ; (*c*) following the use of drugs (such as eserine in glaucoma) applied regularly to the conjunctiva over long periods, as treatment.

Treatment. For the first variety the general conditions of life should be improved, and errors of drainage, and so on, corrected. The second variety, spring catarrh, shows an eosinophilia in the conjunctival discharge. Frequent irrigation and painting the conjunctival surfaces repeatedly with astringent solutions of zinc or collosol argentum combined with adrenaline may cure the condition. In more severe cases applications of unscreened radium (5 mg. for five minutes) have been found effectual. In the third variety discontinuance of the drug is indicated, but this (as in the case of eserine) is sometimes difficult. It will be found that the eserine is less irritating if used in the alkaloid form dissolved in oil and not as the salt in aqueous solution.

(3) *Granular Conjunctivitis.* **Trachoma.** From follicular conjunctivitis this condition must be distinguished carefully. Here the conjunctiva of the upper lid is chiefly and markedly affected and *ptosis* occurs. Before long the superficial layers of the upper portion of the cornea in contact with the inflamed conjunctiva become vascularised (*pannus*). Without treatment the condition spreads until the conjunctival membrane is destroyed and replaced by scar tissue. Vascularisation of the superficial corneal layers increases and infiltration of them may be so dense as to render the whole cornea almost opaque, the sight being gradually destroyed. The disease is common in Asia, especially amongst the Chinese, and in Egypt, where it is endemic. In England it is common amongst the Jews. Trachoma is an infectious condition, and

children so affected are segregated by the London County Council in Trachoma Schools.

Treatment. Many drugs are used in the treatment of this disease. In the early acute stages frequent irrigation and painting of the conjunctivæ with silver nitrate (2 per cent.) may be resorted to, but much staining (argyrosis) results, and the silver nitrate as soon as possible should be replaced by solid copper sulphate (blue stone stick), which can be used indefinitely without staining. If there is serious corneal involvement the use of atropine is indicated. A final resource is treatment, under general anæsthesia, of the conjunctival fornices by "*expression.*" The conjunctival sac having been thoroughly irrigated, the contents of the follicles are expressed with Grady's forceps, and the raw conjunctival surfaces scrubbed with a tooth-brush soaked in 2 per cent. copper sulphate solution, or carbon dioxide snow may be rubbed into the expressed follicles. The eyes of the surgeon and his assistants are protected by goggles during the operation. Extreme care is taken to avoid a secondary infection of the conjunctival membrane afterwards. When the disease is apparently cured an application of the blue stone stick should be given once a month for at least twelve months after all sign of inflammation has ceased. After the disease has been cured a patient can easily be recognised as having had trachoma by the scarring of the palpebral conjunctival and corneal surfaces which remains and by his drooping lid. This is never seen after follicular conjunctivitis, however severe it may have been.

Chronic Angular Conjunctivitis, due to the Morax Axenfeld bacillus, is best treated with lotion and drops containing zinc sulphate (gr. ½ to the ounce).

Parinaud's Conjunctivitis is a chronic condition usually uniocular and seen in young adults. There is congestive conjunctival thickening associated with enlargement of the pre-auricular gland which softens and discharges through the skin. The condition is relieved by tuberculin injections combined with the usual irrigations. The cornea is not involved and the conjunctiva clears up slowly but satisfactorily without impairment of vision.

Diseases of the Bulbar Conjunctiva.

(*a*) **Pterygium.** A yellowish thickening of the conjunctiva occurs in the neighbourhood of the cornea (with its apex away from it) in the eyes of old people, especially those exposed to inclement weather conditions (*pingueculum*). It first appears on the nasal side of the cornea, and extends towards the inner canthus. Should the pingueculum increase in size, Bowman's membrane in its neighbourhood degenerates and the conjunctival thickening spreads and invades the cornea, covering the denuded part and sometimes advancing into the pupillary area (*true pterygium*).

When a fold of chemotic conjunctiva becomes adherent at its apex to the base of a corneal ulcer a condition of *false pterygium* is produced, in which a fine probe can be passed under the fold. This is never possible in the true variety, in which the conjunctiva is adherent to the underlying sclera and cornea for its whole extent, although the margin of the fold may overlap the adherent portion. It is to be noticed that a pterygium is distinguished from a pingueculum by its invasion of the cornea.

Treatment of a pterygium consists in not interfering unless the pupillary area is invaded, when it must be excised. The advancing point may be touched with the cautery and the main part dissected up from the cornea as superficially as possible, continuing the dissection to a fair distance beyond the corneal margin. The bare scleral surface should then be covered with conjunctival flaps drawn in from its margin, while the corneal surface will heal with considerable opacity. Hence little is gained by removing a pterygium to improve the appearance of the eye.

(*b*) **Subconjunctival Hæmorrhage** may be spontaneous or traumatic. The former variety occurs usually in persons past middle life, but may be seen even in children. It follows violent exertion (sneezing or coughing). In whooping cough it may be bilateral and multiple. Its occurrence suggests a high blood pressure and brittle arteries, but is often of very little significance, and too much attention and stress should not be laid upon it. Of the latter type, that due to indirect violence is of great interest to the surgeon. *Fracture of the base of the skull* sometimes occurs without providing any very definite evidence of its presence. Especially is this the case in young children. Within a few days after a severe fall a curious subconjunctival hæmorrhage may appear unaccompanied by any ecchymosis of the lids. The hæmorrhage has the following characteristics: It is "flame-shaped," with its apex *towards* the cornea. It is impossible to reach the base of the hæmorrhage, which disappears behind the outer canthus. The outer side of the cornea is always the one on which the hæmorrhage appears, and it is practically always on the bulbar conjunctiva only. If the lid is affected the hæmorrhage is visible only when it is everted, as the blood comes forward into the orbit from the site of fracture in the neighbourhood of the sella turcica and lies between the conjunctiva and palpebral fascia which always prevents the effusion of blood from being visible externally. Flame-shaped bulbar subconjunctival hæmorrhage is, therefore, a diagnostic sign of obscure fracture of the base of the skull. It may be noticed here that a fractured vault will produce ecchymosis of the external surfaces of the lids, the occurrence of subconjunctival hæmorrhage being prevented by the palpebral fascia. Subconjunctival hæmorrhage due to direct violence may occupy any position, and is almost always accompanied by discoloration and swelling of the lids. All varieties take from three to six weeks to subside, and no treatment (unless applied in the absolutely initial stages, when the effusion of the blood may be checked by ice-cold pads) is of any value in hastening its absorption. (See also Chapter II.)

DISEASES OF THE CORNEA

The cornea is set in the scleral coat of the eye like an inverted watch-glass (the more opaque scleral tissue encroaching upon it superficially) and consists developmentally of three layers :—

(*a*) *Bowman's membrane,* a specialised part of the conjunctiva which is continued over the anterior surface.

(*b*) The *substantia propria* of the cornea itself, which is formed of specialised scleral tissue.

(*c*) *Descemet's membrane,* a specialised part of the uveal tract, which is continuous from the iris over the back of the cornea, and thus forms its deepest portion.

The effects of trauma and inflammation upon those three layers of the cornea give rise to six corneal conditions seen in ophthalmic practice.

(A) Superficial: Bowman's membrane (new vessels of the conjunctival type).

1. Trauma : Foreign bodies and wounds.
2. Inflammation : Corneal ulcer.

(B) Substantia propria (new vessels of the scleral type).

3. Trauma : " Bloodstaining of the cornea."

4. Inflammation : Interstitial keratitis. (Syphilis, tuberculosis, sepsis.)

(C) Deep : Descemet's membrane (avascular ; condition symptomatic and not inflammatory).

5. Trauma : Striate keratitis.

6. Inflammation : Keratitis punctata.

Injuries and Foreign Bodies. These affect chiefly Bowman's membrane. Trauma is inflicted by the presence of foreign bodies, or the cornea may be wounded by a direct blow.

(*a*) *Foreign Bodies.* The presence of a foreign body upon the cornea is best detected by examination with the lens and loupe. After irrigating the conjunctival sac, its removal is carried out under cocaine by means of a " spud." The patient should be seated with his head supported, and the surgeon should stand behind him. The lids are best retracted with the first and second fingers of the surgeon's left hand resting actually upon the cocainised bulbar conjunctiva. The foreign body is removed by gentle " to-and-fro " movements of the spud ; if it is metallic or has been present some time, staining will be produced around it by leucocytic phagocytosis, and as much of this must be removed as possible. The work can be facilitated greatly by wearing a binocular loupe and focussing light upon the area of operation with the 13 D. lens. No patient should leave the hospital after removal of a foreign body, which has resulted in corneal abrasion, without having his visual acuity recorded or, if under cocaine, without wearing a pad and bandage.

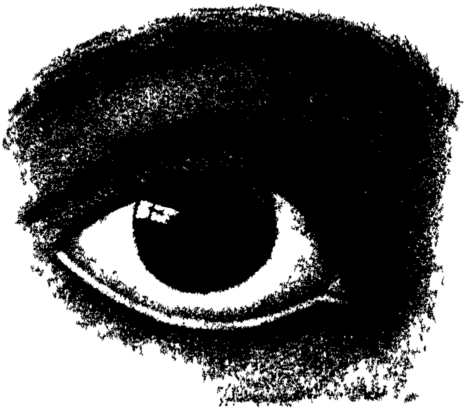


FIG. 88. Bloodstaining of the cornea, following a blow from a blunt object. This was preceded by a hyphæma. The mydriasis shown is traumatic and not due to drugs. *Drawing by T. Hamblin Ltd.*

(*b*) *Wounds.* A corneal wound may be perforating or non-perforating.

1. *Non-perforating wounds* may be superficial abrasions, so slight as to be difficult to detect, or so severe as to damage the underlying structures, giving rise to hæmorrhage from the iris into the anterior chamber (hyphæma), dislocation or destruction of the lens, or detachment of the retina.

A very slight corneal abrasion, though causing considerable discomfort, may be almost invisible until stained by the instillation of fluorescein (1 per cent.).

Non-perforating corneal injuries accompanied by hyphæma may result in an interesting condition known as "bloodstaining of the cornea." Here, although the superficial corneal layers are intact, the deeply-placed Descemet's membrane may be ruptured, allowing the blood in the anterior chamber to infiltrate the corneal lamellæ and give rise to an appearance very closely resembling a lens dislocated into the anterior chamber. The condition clears up rapidly and completely.

2. *Perforating injuries* of the cornea are complicated:—
   (*a*) By the injury or infection of deeper structures and their prolapse through the wound.
   (*b*) By **sympathetic ophthalmia,** which results from injuries which involve the limbus (the area of junction of the cornea and sclera) and the underlying ciliary body (known as the "danger area").

In this condition an *iridocyclitis* is set up in the injured eye, usually between the fourth and tenth day after the injury, accompanied by a plastic exudate into the anterior chamber and the usual signs, especially the formation of a keratitis punctata, which are referred to under diseases of the uveal tract. The onset of sympathetic inflammation in the sound eye is preceded by a stage of irritation, during which the sympathising eye shows some photophobia and lacrimation and flushes on examination. During this stage the spots of keratitis punctata, though not visible by ordinary clinical methods, have been detected by the slit lamp.

The onset of sympathetic *irritation* in the sound eye is the signal for the immediate removal of the injured one. If this is done the irritation, in the vast majority of cases, does not proceed to inflammation.

If iridocyclitis, as evidenced by the clinical manifestation of keratitis punctata, has already started in the sympathising eye, the injured one must not be removed. It may be ultimately the better eye of the two.

The causal agent in sympathetic ophthalmia is unknown, but two facts are of interest: (*a*) If a differential blood count is done an eosinophilia is found. (*b*) Injections of salvarsan have been found to have some partial curative effect upon the condition. It must not be thought, however, that syphilis is in any way the cause. (See removal of an injured eye, p. 292.)

Inflammations.

(A) **Superficial Keratitis.** A **corneal ulcer** results from an infected abrasion. A chronic septic condition of the lacrimal sac predisposes to such a condition. Corneal abrasions are of relatively frequent occurrence, and hence the importance of removing an infected lacrimal sac is great. When an ulcer develops the cornea becomes vascularised, new vessels being developed in a normally avascular structure to remove dead material and provide for the repair of the denuded area. Bowman's membrane being a specialised part of the conjunctiva, the new vessels are of the *conjunctival* type. A leash of vessels grows inwards towards the centre of infection, having sinuous courses and tree-like branching—quite different from that seen in inflammation of the substantia propria. As the ulcer extends more deeply into the cornea, leucocytes are attracted by chemiotaxis into the anterior chamber in increasing numbers until they begin to collect at the lower part of it (*hypopyon*). This collection is not pus, as culture of the fluid found in hypopyon proves it to be sterile. If the ulcer continues to spread more deeply the membrane of Descemet begins to be involved. The weakened cornea now begins to yield before the intraocular tension, and Descemet's membrane, being tougher than the layers more superficial to it, may bulge out of the floor of the ulcer, giving the appearance of a black bubble in this situation (*Descemetocele*). The anterior chamber is now embarrassed with inflammatory exudate from the ulcer, and drainage from it along the canal of Schlem may be further hampered by the occurrence of iritis, leading to a rise of intraocular tension (secondary glaucoma), which aggravates the Descemetocele and results in perforation. This final stage is often unexpectedly followed by improvement due to the reduced intraocular tension and consequent improvement in the corneal circulation. Eyes which have been saved after perforation of a corneal ulcer often show a small white patch upon the anterior surface of the lens (anterior polar cataract), which had been brought into contact with the floor of the ulcer by the escape of aqueous and had formed part of it till the anterior chamber reformed. After the ulcer has healed, the corneal scarring which results from it is often very dense (*leucoma*), which seriously interferes with vision, but even if this is not so, an irregular astigmatism is often produced which it is impossible to correct with glasses, yet has a marked effect in lowering visual acuity.

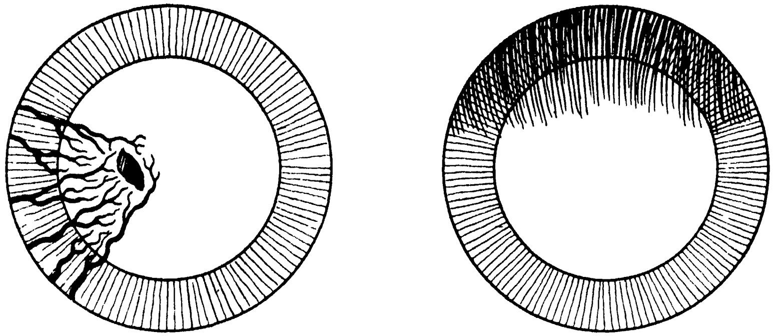
The *treatment of a corneal ulcer* consists in providing frequent irrigation of the conjunctival sac, and possibly sterilising it as far as possible by painting the conjunctival surfaces of the lids with silver preparations. The pupil should be kept dilated with atropine so as to immobilise it in as safe a position as possible, keep it from contact with the deep parts of the cornea, and prevent a prolapse should the ulcer perforate. The eye should be kept covered with a pad and bandage. If the ulcer continues to spread, it may be carbolised. The lids are retracted with a speculum, the surface of the eyeball cocained, and conjunctival secretion dried with blotting paper. The surface of the ulcer is then touched with a pointed match stick dipped in carbolic acid (10 parts in 11) or absolute alcohol, special attention being paid to any overhanging edges which may be present. This procedure may be repeated if there is a temporary improvement in the progress of the condition, and may succeed eventually. Should this fail and the ulcer continue to spread, with the formation of a Descemetocele, the good results of perforation may be anticipated.

Saemische's section. This operation is carried out to save the eye at the expense of the sight perhaps. An incision is made horizontally across the cornea opening up the anterior chamber, and beginning and ending, if possible, in healthy corneal tissue. The lens must not be wounded during the operation, but prolapse of the iris cannot be avoided. It will become entangled in the wound, and its presence there may help in the vascularisation of the poorly nourished cornea, and so promote healing of the ulcer.

Raised intraocular tension in the case of a progressing cornea ulcer should lead to the substitution of an ointment of eserine and iodoform for the atropine for the following reasons: The ulcer in this way may be disinfected, and the intraocular tension lowered. Contracting the pupil will bring the iris into contact with the deep corneal surface in case of a perforation, and the adherence there of this vascular structure may increase the nutrition of that part of the base of the ulcer which is farthest from its blood supply.

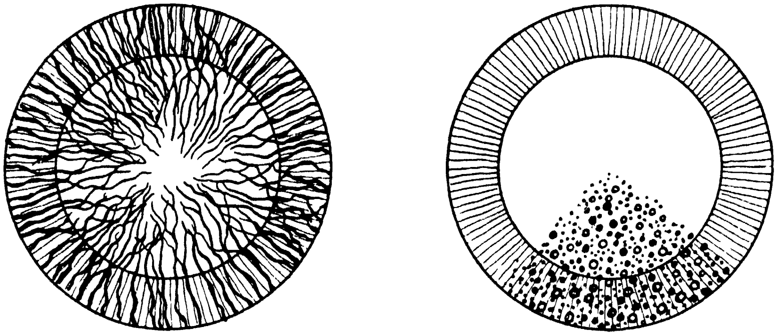
(B) **Interstitial Keratitis.** Inflammation of the substantia propria of the cornea results from Syphilis or Chronic Sepsis, and has been said on occasion to be due to Tuberculosis. Of these causes the first is by far the most common. Interstitial keratitis occurs as one of the manifestations of inherited syphilis, and is much commoner in girls than in boys (9 to 1). It usually occurs between the ages of five and fifteen years, and one eye having been attacked, the other is almost sure to be similarly affected sooner or later.

An attack of the disease lasts from four to six months, and consists of a *panophthalmitis*, all three coats of the eyeball being involved. The inflamed cornea usually obscures the presence of more deep-seated lesions, but in the early stages it may be possible to observe an accompanying iridocyclitis and choroido-retinitis. The cornea is invaded by new vessels of quite a different type from those seen in corneal ulcer. The vascularisation is of the *scleral* type, the vessels being very fine and closely set in parallel lines. The branches, coming off at an acute angle, proceed in the same direction as the parent stem from the whole corneal circumference to its central point. Peripherally, in the upper part of the cornea a crescentic patch is usually found where the vascularisation is so intense that the cornea becomes salmon-coloured (*salmon patch*). The translucency of the cornea is lost as the result of the vascularisation and inflammatory infiltration, so that no view of the anterior chamber is obtainable, and the reaction of the corneal tissues may be great enough to result in an *intracorneal abscess*. Such an abscess, however, is commoner in interstitial keratitis resulting from chronic sepsis. As the inflammation subsides the infiltrated cornea begins to clear, but opacity remains in the centre of the cornea (the part furthest from the blood supply) until the last, and is never quite removed from this area, with the result that interstitial keratitis has in the majority of cases a distinct tendency to reduce the acuity of vision; taking a series of cases, the average visual acuity after an attack is 6/24ths.



VASCULARISATION IN CORNEAL ULCER (SUPERFICIAL .

APPEARANCE OF STRIATE KERATITIS.



VASCULARISATION IN INTERSTITIAL KERATITIS.

APPEARANCE OF KERATITIS PUNCTATA.

Fig. 89. To illustrate diseases of the cornea.

Treatment consists in protection of the eyes from the light so as to reduce lacrimation and photophobia, and bathing them with hot lotion to reduce the pain of ocular congestion. Owing to the accompanying iridocyclitis, the pupils always should be dilated at the commencement of the attack. Antisyphilitic remedies should be applied, especially intravenous bismuth salvarsan. It has been thought that paracentesis of the anterior chamber at the time that salvarsan is injected may help by removing inflammatory products and assisting the secretion of salvarsan from the ciliary body along with the new supply of aqueous, but the matter is still sub judice. As interstitial keratitis is a painful and protracted disease, during which the patient may be almost blind, every care must be taken to maintain general nutrition, which is apt to fail under the ordeal.

Interstitial keratitis complicating chronic sepsis presents a different clinical picture to that occurring as a manifestation of inherited syphilis. The keratitis is localised and unilateral, a *corneal abscess* is liable to be present, and corneal staphyloma may add to the gravity of the condition. Panophthalmitis is not as a rule seen. Discovery and removal of the source of sepsis (*e.g.*, pyorrhœa alveolaris) will produce rapid improvement, but without this the eye tends to become seriously injured, and may be lost. Treatment along the usual lines by hot bathing, atropine and a pad and bandage must be carried out together with evacuation of the corneal abscess. If a corneal staphyloma appears, eserine should be used in place of atropine.

(C) **Deep Keratitis.** This condition affecting Descemet's membrane is symptomatic of inflammation or injury rather than the reaction of the cornea to infection, and to that extent is a misnomer. Two types may be mentioned, one associated with trauma and the other with inflammation.

(*a*) **Striate keratitis** is most often seen after operations requiring a corneal incision, such as the extraction of a senile cataract. In the delivery of a large crystalline lens through a corneal incision which is perhaps too small the cornea is somewhat distorted, and Descemet's membrane is thrown into a series of folds. These folds, invisible at first, are raised into prominence by the adherence to them of inflammatory exudate thrown out by a ciliary body suffering from slight traumatic cyclitis. An appearance is presented of a series of parallel white lines, deep in the cornea, which tend to disappear as the original injury becomes more remote and the cyclitis subsides.

(*b*) **Keratitis Punctata.** This condition is symptomatic of inflammation of the ciliary body. When this structure becomes inflamed it secretes abnormal aqueous into the anterior chamber, in which are leucocytes and pigment cells thrown off by the ciliary body, forming part of the uveal tract to which Descemet's membrane morphologically belongs, and it is thought that this membrane takes part in a cyclitis in so far as to become denuded of its epithelium to some extent. To these denuded spots leucocytes and pigment cells circulating in the anterior chamber adhere, and on the back of the cornea, in cases of cyclitis, are seen a series of small white, dot-like deposits, some being so small as hardly to be visible on oblique illumination with the lens and loupe, while others are so large as to be termed "mutton-fat deposits." These occupy the lower quadrant of the corneal disc, the smaller spots being nearer the centre of the cornea, and the larger in relation with its lower margin. Occasionally Descemet's membrane is also thrown into folds which, being rendered visible by exudate adhering to them, give rise to a striated appearance.

Keratitis, iritis and cyclitis give rise to circumcorneal injection of the eyeball. The four anterior ciliary arteries are branches of the vessels to the recti muscles, appearing from under their tendons. These arteries pierce the sclera just behind its junction with the cornea and, by anastomosis with each other and the terminal branches of the long ciliary arteries, form a vascular ring which supplies the ciliary body and iris. Posteriorly blood circulates between this ring and the terminal branches of the short ciliary arteries, which pierce the sclera around the entrance of the optic nerve to supply the choroid coat of the eyeball (see p. 256).

Evidence of old keratitis or cyclitis is present for a very long time after inflammation has subsided and may be obtained by examining for corneal vascularisation and keratitis punctata (K.P.).

Bowman's membrane is morphologically conjunctival in origin, and new vessels formed as a result of ulcerative keratitis or in the "pannus" accompanying granular conjunctivitis are of the conjunctival type, whereas the substantia propria, being of scleral origin, shows vessels of the scleral type.

The spots of keratitis punctata symptomatic of cyclitis also may be present after a long interval, though altered in two ways. They may become so faint as to deserve the name of "ghosts," or their whitish appearance due to the leucocytes thrown out by the inflamed ciliary body may be altered by the removal of the leucocytes and the spots of the deposit may become black, the pigment cells which accompanied the leucocytes being at length rendered visible.

These vestiges of old inflammation may be looked for by oblique illumination of the cornea with the lens and loupe, or with the ophthalmoscope by the direct method with a plus 20 D. lens before the surgeon's eye. The depth of any structure in the cornea is best examined by means of a binocular loupe ; as stereoscopic vision renders this easier to determine. Vestiges of central corneal opacities and infiltration with vessels of the scleral type are so permanent after interstitial keratitis that a search for them may repay the surgeon in cases of obscure disease elsewhere in the body. Finding them makes the diagnosis of inherited syphilis practically certain.

Herpes Ophthalmicus. Inflammation of the ophthalmic division of the Vth cranial nerve may give rise in its early stage to difficulties in diagnosis between this and acute glaucoma. As the condition develops corneal lesions may occur breaking down and becoming ulcerated. They heal with considerable difficulty and tend to relapse on account of the corneal anæsthesia which persists. Sometimes iridocyclitis and raised intraocular tension occurs. The distress caused seems to vary with age, while elderly patients—the usual sufferers—may be in very great pain, one case, a child of four years, was in scarcely any discomfort. The association of the condition with epidemics of chicken pox should be remembered. Treatment consists of calamine lotion to the affected area. Leeches and heat will relieve pain, while appropriate treatment will be directed to corneal ulceration and possible iridocyclitis and rise of intraocular tension.

A recurrence of pain in the affected area may be expected with the return of cold weather.

DISEASES OF THE SCLERA

Scleritis of the eyeball is not often seen. Pain on pressure on the eye accompanies congestion of the scleral vessels, disposed in a close network. A reddish purple patch appears over the sclera from which the blood cannot be expressed by pressure through the lid. If the inflammation is superficial the patch is slightly raised above the general surface, from œdema of the scleral tissue. Superficial inflammation commonly occurs near the corneoscleral junction (episcleritis). Scleritis may be traumatic or inflammatory. The former variety results from a foreign body which may be retained, while the latter may be acute or chronic according to the exciting cause which is carried to the sclera by the blood stream.

The condition lasts as a rule for long periods and atrophy of the sclerotic coat is apt to intervene, showing itself by the formation of an area in which the sclera gives way before the intraocular tension (*staphyloma*) or in which the dark choroid can be more easily seen than elsewhere through the abnormally thin overlying coat.

Treatment consists in alleviating the symptoms and discovering and removing the cause. Pain and redness are met by atropine and hot bathing and by keeping the eye covered. Continuous dry heat or a leech may assist with the pain, which may be great from the distension of the tense scleral lamellæ with inflammatory products. In the more chronic type inflammation (here as in the cornea and uveal tract) may be treated by increasing the tissue reaction to infection by repeated instillation of dionine (2 %—4 %) into the conjunctival sac, producing a temporary chemosis, increase of leucocytic activity, and gradual improvement. The cause is to be sought in unhealthy conditions of the gastro-intestinal, respiratory, and urogenital tracts. Chronic alcoholism sometimes gives rise to episcleritis, which is then a manifestation of "subinfection." The causes of these chronic inflammatory conditions are more easily sought than found.

THE UVEAL TRACT

This tract forms the middle coat of the eyeball and is complete, consisting of the iris, ciliary body and choroid. It is continued forwards from the iris over the back of the cornea as Descemet's membrane, which takes part in lesions of the tract. The functions of this coat are to provide for the nutrition of the structures of the globe, to supply the power for the intraocular mechanisms of accommodation and pupil reaction, and to produce the aqueous which fills the anterior chamber. The arterial supply of the uveal tract has previously been described (see p. 246). Venous blood leaves the eye by two routes. The chief choroidal veins lie external to the arteries (except the long ciliary arteries), are disposed in curves (venæ vorticosæ), and collected into four or five principal trunks which pierce the sclera halfway between the corneal margin and entrance of the optic nerve passing into the superior and inferior ophthalmic veins. By this route most of the blood from the iris and ciliary body, as well as that from the choroid, leaves the eye. Blood also can pass by the anterior ciliary veins, which collect it from the ciliary muscle and run with the corresponding arteries to join the vessels of the recti. These veins are intimately connected with the circulation through the canal of Schlemm in the angle of the anterior chamber, and become distended in glaucoma.

The Iris. This structure forms a muscular curtain, the size of the aperture in which can be controlled. It is plentifully supplied with blood from two concentric arterial circles, with radial anastomoses running between them, and consists of two layers:—the anterior, of two sets of muscle fibres, the circular ones (constrictor pupillæ) supplied by the third nerve and the radial (dilator pupillæ) by the cervical sympathetic; the posterior, made up of a pigment epithelium derived morphologically from the retina, which gives the iris its colour.

Lesions of the iris may be congenital, traumatic, neoplastic or inflammatory, and will be considered under these heads :—

(A) *Congenital.* **Coloboma of the Iris.** Embryologically the eyes develop as a pair of hollow protrusions from the forebrain. These protrusions become pitted so as to form cups, and finally are folded so as to enclose the central retinal artery. Failure of the edges of the cleft so formed to unite efficiently produces a gap in the retinal and uveal coats which may be complete or partial, and occupies the lower and inner part of the eyeball. Occasionally total congenital absence of the iris (aniridia) is seen. Congenital malformations are often multiple and frequently inherited. If such a gap is present in the iris other congenital irregularities should be looked for.

Persistence of the Pupillary Membrane. The layer of mesoderm in which the iris is developed originally formed a continuous sheet in front of the lens, and occupied the anterior chamber and the pupil gap. This membrane contained vessels which were branches of the inner vascular circle of the iris. Errors of growth may take place in two directions. The membrane may be absorbed, while vestiges of its vessels may remain as a series of white strands springing from the inner vascular circle of the iris (not from its edge) and being either attached to the anterior lens capsule or united together in a knot which floats loosely in the anterior chamber. The vessels, on the other hand, may be normally removed, while the membrane itself persists as an area of fine, often pigmented opacities seen in the centre of the anterior surface of the lens.

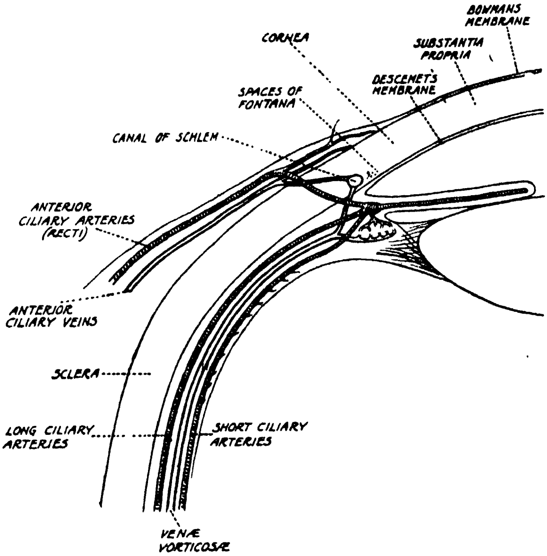


FIG. 90. To show the canal of Schlem and the major arterial circle of the iris.

(B) *Traumatic.* (1) **Prolapse of Iris.** In perforation of the cornea, escape of aqueous may cause the iris to prolapse through the wound. In such a condition the iris prolapse must be drawn further out of the wound with iris forceps and cut off through healthy tissue with iris scissors; the edges of the traumatic coloboma thus formed will spring back within the eye, being replaced out of contact with the wound and without being folded upon themselves, by the iris repositor. The pupil should be kept dilated with atropine, and the eye bandaged until the anterior chamber has reformed.

(2) The iris may be injured by direct blows upon the eyeball, a few of the circular muscle fibres being torn, rendering the pupil of the injured eye permanently larger and more inactive than that of the other (*Traumatic Mydriasis*). Under these circumstances minute tears can be seen at some point along the free edge of the iris (see Fig. 88).

(3) The iris may be torn from its attachment to the ciliary body peripherally where it is thinnest (*Iridodialysis*). By oblique illumination a black crescentic area may be seen at a point at its periphery with corresponding irregularity of the free edge. Light may be projected by the ophthalmoscope mirror through the dark crescent and a red reflex obtained.

Laceration of the iris is usually accompanied by effusion of blood in the anterior chamber (Hyphæma).

(4) **Cysts in the Anterior Chamber** result from trauma. They may be due to the proliferation of epithelium carried in by a perforating instrument or may grow from the iris after the injury. Many contain foreign bodies, such as a piece of metal or an eyelash. The history of injury is sometimes vague, so that the conditions closely resemble those due to neoplasm, but the finding of evidence pointing to inflammation, such as synechiæ, or floating vitreous opacities, is in favour of trauma as against neoplasm.

(C) **Neoplasms of the Iris.** The pigmentation of the iris is often disposed in patches, some parts being much darker than others. Sometimes a dark spot (mole) is to be seen in the iris, but this is found on careful examination not to be raised above the general level of the surface. If the *spot is found raised above the level of the iris* a neoplasm is almost certainly present. It should be removed by iridectomy with the piece of iris from which it grows and submitted to microscopy. The structure of such a growth may be that of a **melanotic sarcoma.** It is often extremely malignant, spreading by the blood stream and forming metastases in the skin and internal organs. The amount of pigment in the secondary growths is variable, but it may be very large indeed as compared with the primary one. It may be worth mentioning here that in the diagnosis of obscure swellings in the upper abdomen, that of secondary metastasis in the liver, spleen or kidney should be considered and two sites of primary growth always examined—the eye and the testicles. The eye may have been removed, and a good glass one may, in the stress of examination, evade observation, while the absence of a testicle may be concealed unobtrusively by a blanket. The course and symptoms of undiagnosed intraocular growth are further considered under causes of glaucoma (see p. 269).

(D) *Inflammatory.* **Iritis** results from a bloodborne infection originating in the gastro-intestinal, respiratory, or urogenital tracts, or may complicate diabetes or nephritis. It is characterised by pain, photophobia, circumcorneal injection and effusion of inflammatory products into the anterior chamber, leading to the adhesion of the iris to neighbouring structures and predisposing to secondary glaucoma. In acute iritis symptoms must be treated. The inflamed iris is put at rest by atropine, which dilates the pupil and prevents adhesion of its free edge to the anterior surface of the lens. Hot bathing must be instituted for the congested iris vessels, which may be further relieved and pain reduced by the application of leeches. The diet should be fluid and the bowels adequately opened by purging If one eye only is affected, a pad and bandage should be applied.

In chronic iritis the cause is most important. The history of the patient must be inquired into, his teeth, nasal sinuses, gastro-intestinal and uro-genital tracts investigated, the urine examined and the Wassermann blood test done. Until a cause has been found the patient is not safe. Iritis tends to be recurrent, the acuity of vision is often reduced by each attack, and secondary glaucoma may supervene at any time.

Synechiæ—Iris adhesions—may occur anteriorly to the cornea or posteriorly to the lens. They may be peripheral, at the angle of the anterior chamber, obstructing drainage through the canal of Schlem, or central, of the free edge of the iris to the anterior surface of the lens, hampering its movements. *Seclusion of the pupil* results from a total posterior ring synechia, the whole circumference of the free iris margin becoming adherent to the lens. This must be distinguished from *occlusion of the pupil* when it is blocked by inflammatory exudates poured out into the anterior chamber. Total posterior ring synechia results in the iris being ballooned forward by the imprisoned secretion of the ciliary body (*Iris Bombé*), and will result in secondary glaucoma unless relieved. Such a condition will not occur if atropine has been efficiently used in the early stages of the attack.

Iritis, whatever the cause, will present the symptoms and complications outlined above and require similar treatment, but the various types present certain clinical differences.

(*a*) **Gonorrhœal iritis** is of an unusually severe kind, and is accompanied by a *gelatinous exudate* into the anterior chamber, which may cohere to such an extent as to resemble a lens dislocated into this situation. The pupil is frequently occluded and sight materially impaired, while seclusion and iris bombé are frequently seen.

(*b*) **Syphilitic iritis** occurs at two stages of the disease. As a secondary manifestation it resembles acute iritis of the ordinary type, and is accompanied by a generalised rash, joint effusions, sore throat, and a considerable amount of general malaise. In every case of acute iritis with which he is suddenly presented, the possibility of a genital infection and the presence of a rash should occur to the surgeon. Not to make such an obvious deduction is embarrassing. Syphilitic iritis also occurs in the third, or gummatous, stage of the disease, and, with *Tuberculous Iritis*, presents itself as a nodular iritis, having a chronic course. The nodules are avascular as compared with the iris from which they spring, and are generally multiple, two or three being present. It can be noted here that iritis accompanied by arthritis has, in recent years, complicated cases of bacillary dysentery.

The Ciliary Body, situated behind and external to the iris, is disposed in a ring around the eyeball from the corneoscleral margin to a point anterior to the equator of the globe. Anteriorly continuous with the iris and posteriorly with the choroid, it is in relation externally with the sclera, while it is covered by a pigment layer morphologically derived from the retina. The free anastomosis of the uveal arteries and veins already has been described. The ciliary body consists of two parts, the ciliary muscle and the ciliary processes. The ciliary muscle occupies the outer part, and has a fixed point *anteriorly* near the cor-

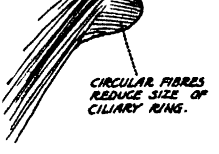

LONGITUDINAL FIBRES RELAX LIGAMENTS OF LENS
CIRCULAR FIBRES REDUCE SIZE OF CILIARY RING.

Fig. 91. The ciliary muscle.

neoscleral junction from which the fibres are directed backwards and inwards and are connected to the bottom of a series of grooves between the ciliary processes. Upon the grooves themselves are placed the glands which secrete the aqueous, while from the tips of the ciliary processes arise the suspensory ligaments of the lens. When the ciliary muscle contracts, the whole ciliary ring is drawn forwards and occupies a smaller circumference of the globe. The suspensory ligaments are thus relaxed and the *lens surfaces rendered more convex by the natural elasticity* of that body. This elasticity is diminished with advancing years by the development of sclerosis of the lens, and hence the amplitude of accommodation fails.

Cyclitis. Inflammation of the ciliary body, the result of injury or infection, seldom affects this structure alone A tissue reaction is also seen in the iris and in Descemet's membrane accompanied by changes in the aqueous and vitreous, evidenced by the gradual development of synechiæ, the appearance of keratitis punctata (K.P.) upon the cornea, and the formation of a cloud of very fine opacities, floating in the vitreous, indicating that this body is no longer jellylike, but has been rendered fluid. In "quiet cyclitis" the K.P. are occasionally few in number and very small, and to be found only by very careful examination by good oblique focal illumination with the lens and loupe. This type of cyclitis often evades observation, the first hint that anything is wrong being an attack of apparently acute glaucoma, resulting from slowly developing peripheral adhesions between the iris and cornea, obstructing drainage through the canal of Schlem.

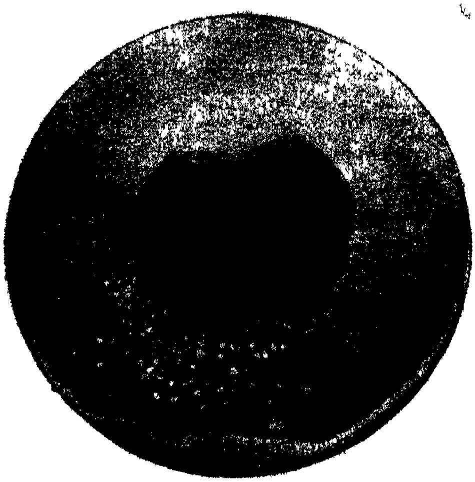


FIG. 92. A case of Iridocyclitis in which all tests were negative and treatment unsuccessful until tuberculin had been given. (Note (1) the Keratitis punctata upon the cornea, (2) the iris with an irregular margin dilated with atropine, and (3) the exudate in the anterior chamber.)

1. *Traumatic cyclitis*, following perforating injuries in the "danger area," with the attendant risks of "Sympathetic Ophthalmia," has been described under injuries of the cornea (see p. 245).

2. *Purulent cyclitis* results from direct infection from a perforating injury or metastatic inflammation carried by the blood stream in cases of pyæmia. The eye becomes blind from effusion of septic exudates into the aqueous and vitreous, and from secondary rise of intraocular tension. In the early stages a green reflex replaces the usual black appearance seen on looking into the pupil by ordinary daylight. In the metastatic variety the patient is often so ill, and dies so soon from his associated condition, that nothing need be done. In the purulent cyclitis, or *Panophthalmitis*, of direct infection, the eye must be removed. Care must be exercised or this will result in meningitis by infection along the lymph paths of the stump of the optic nerve and orbit. In younger patients the potential spaces between the arachnoid and dural

sheaths of the optic nerve may be real ones, communicating with the corresponding intracranial spaces, and, infection thus finding a direct channel along which to pass, meningitis may ensue. Hence, in these cases, the scleral coat is left in attachment to the optic nerve, but is eviscerated. It may be opened by a crucial incision or by removal of the anterior portion of the globe of the eye, and the remaining contents removed by very gently scraping the interior of the scleral cavity. When inflammation has entirely subsided the remnant of sclera may be removed from the optic nerve and the back of the orbit covered in by flaps of conjunctiva in the usual way.

The cause of cyclitis may be quite clear, as in the traumatic and purulent varieties, or extremely obscure. It may only reveal itself after a careful search of all the possible sources of infection, or the cyclitis may subside as the result of treatment without discovery of the exciting cause. These latter cases are often recurrent and frequently lead to the complication of secondary glaucoma with loss of sight.

The *treatment* consists in discovery and removal of the cause. Locally, hot bathing should be employed and the pupil kept dilated with atropine. Intestinal antiseptics and aperients will generally assist in the elimination of toxins. A careful watch should be kept on cases of cyclitis to recognise complications at the earliest possible moment.

Sarcoma of the ciliary body, of the melanotic variety, may occur, and appears as a low elevation in this region, often visible when the pupil is dilated.

The Choroid Coat of the eyeball consists of a vascular network, of which the smallest meshes (choriocapillaries) lie internally towards the outer layers of the retina which are nourished by them. The free communication of the arteries and veins has already been noted. Externally lies the sclera.

The choroidal coat may be affected by injury or inflammation. In cases of *albinism*, in which the retinal pigment is defective, the larger choroidal vessels can be seen quite plainly, and a similar condition may be present in myopia, especially in children.

Choroidal Injuries. Blows upon the eye may cause rupture of the choroid without damage to the overlying sclera. This rupture can be seen clearly with the ophthalmoscope, appearing as a narrow white line, which tends to be concentric with the disc and to pass for a long distance across the fundus. At one end the split may divide into branches, gradually fading away into the surrounding tissues. Along the course of the tear, white because the sclerotic coat shows through a gap in the choroid, may be found a variable amount of pigment indicating that some choroiditis has occurred at the site of the injury. If the tear crosses the fundus in the region of the macula, very marked reduction in the acuity of vision would be expected to result, but choroidal injuries may take place in the periphery of the fundus and yet be complicated by this untoward result. After the perforating bullet injuries of the war a state of affairs was seen so frequently as to be looked upon as typical in such cases. The scleral coat of the eye, grazed by the passage of a bullet through the orbit, was not perforated, but so severely bruised as to produce a considerable effect upon the choroid and retina as well. This was shown by: (1) An area at some point, often at the extreme periphery of the fundus, corresponding to an entrance or exit wound, where a variable amount of radiating tears, new fibrous tissue and choroidal pigmentation indicated the site of the injury (sometimes a foreign body could be located as well). (2) A macular region which showed slight ("concussion") changes—alteration of colour and a little pigmentation. Apart from these two lesions the fundus was normal and the media clear. Yet the vision was reduced to perception of light, the reduced visual acuity being out of all proportion to the visible severity of the macular changes.

Choroiditis. From "active choroiditis" must be separated carefully the evidence, which is frequently to be seen in eyes which are no longer inflamed, of choroiditis having occurred at some previous time.

Inflammation in the choroidal coat of the eye is evidenced by redness, swelling, heat, pain and loss of function, although the increase of heat is difficult to demonstrate clinically. Redness is of the circumcorneal type and is not so marked as in those cases where the anterior part of the uveal tract is involved. *Swelling* is obvious upon ophthalmoscopic examination by the details in some portion of the fundus being obscured. The retina frequently takes part in the tissue reaction to infection, and it will be found that the course of the retinal vessels becomes "hazy," and that they disappear into an area of "cloudy swelling" which may, in favourable cases, be made out to be considerably "forward" in the vitreous, and be more clearly seen by putting up a plus lens between the observer's eye and the ophthalmoscope mirror. In such a case the patient may be said to have (for example) "+ 2 dioptres of swelling" in some part of the fundus. The areas of choroiditis may be single or multiple. Most frequently the presence of the cloud of fine vitreous opacities, symptomatic of uveal inflammation, obscures any clear view of details. Pain of an aching character accompanying vascular congestion is present. Loss of function is indicated generally by reduction of the acuity of vision owing to the vitreous opacities, and locally in a minority by being able to show (on charting the visual field with McHardy's perimeter) a loss of the field corresponding to the area of the fundus involved in the choroiditis. Keratitis punctata and synechiæ are not present unless the ciliary body and iris take part with the choroid in a "pan-uveitis."

Treatment consists in eliminating the causal infection (which may be difficult to find), providing rest with atropine and a pad and bandage, increasing local resistance by means of hot bathing or continuous dry heat, and assisting excretion as far as possible.

In contrast to choroiditis, the acute stage of which is not often seen, and in any case is difficult to examine, the *results of old choroiditis* are easy to observe and frequently seen in patients coming for treatment. Two types are most common: that due to syphilis and that occurring as the result of chronic sepsis. On examination of the fundus multiple irregular, massive deposits of pigment of quite irregular shape alternate with spots of choroidal atrophy in which this tissue has disappeared, rendering visible the white sclerotic coat beneath. The retina frequently takes part to some extent in choroiditis, but where uncomplicated choroiditis has been present the retinal vessels will be found to cross the atrophic areas and pigment deposits, both of which are, therefore, deep to them. In old choroido-retinitis, on the other hand, the vessels will be seen obscured by the pigment deposits.

In cases due to syphilis pigment proliferation has been largely in excess of atrophy, and evidence of old *choroido-retinitis* will be revealed which has occurred at one of these periods of life: (1) as an early congenital manifestation between the ages of three and six years; (2) as a part of the panophthalmitis which accompanies interstitial keratitis; or (3) as a later manifestation of acquired "tertiary" syphilis.

Choroiditis of chronic septic origin is seen most frequently to have occurred in myopia. Perhaps a chronic "quiet" inflammation of the posterior part of the uveal tract may do more to account for a progressive tendency in myopia than is generally admitted, so that bad teeth, an unhealthy naso pharynx, or other fault should never go untreated in these cases. Here atrophy is much more marked than pigment proliferation, which is often hardly noticeable.

We have referred to the tendency of different parts of the uveal tract to be affected together in inflammations of this region. The iris, ciliary body, and Descemet's membrane are affected together in iridocyclitis (*anterior uveitis*), while some cases of progressive myopia may be due to a " quiet " choroidocyclitis of septic origin leading to failure of nutrition of the posterior part of the sclera and the formation of a posterior staphyloma (*posterior uveitis*). Sometimes the macular region of the fundus seems to be affected by a choroidal inflammation which is followed by a variable degree of failure of the acuity of vision. The origin of this type of lesion is usually quite obscure, but it is held by many to be due to the toxæmia of a chronic focus of infection (*central uveitis*). Lastly, an inflammation of the whole uveal tract may occur in the course of the acute specific infections, characterised by the presence of " k.p." effusions into the anterior chamber, synechiæ, floating vitreous opacities and, as the vitreous clears, the presence of the scars of choroiditis, pigment proliferation, and choroidal atrophy (*pan-uveitis*). Such a condition is seen in syphilitic interstitial keratitis, and I have myself had a case of pan-uveitis occurring in the course of whooping cough.

Choroidal sarcoma of the melanotic type is referred to again under diseases of the retina as a cause of retinal detachment (p. 268).

DISEASES OF THE LENS AND THE VITREOUS

The crystalline lens is attached to the ciliary body by the suspensory ligaments and held by them behind the iris, with the posterior pigmented surface of which its anterior surface is in contact. The lens is formed from a downgrowth of epithelium from the surface, communication with which is afterwards cut off. The centre or nucleus is the oldest and hardest portion. The cortex is produced by continuous epithelial proliferation, and as fresh layers are laid down upon the outside the older and inner layers cannot be thrown off; the lens grows from birth to old age. An anterior lens capsule is present, but no corresponding posterior structure is to be found under normal conditions.

Dislocation of the lens may occur either as a congenital defect or as the result of trauma. The dislocation may be *partial*, in which the edge of the lens can be seen in the pupil area and the patient may complain of uniocular diplopia. On ophthalmoscopic examination two discs of different sizes may be seen, one through the lens and the other through the gap between its edge and the pupil margin. If dislocation is partial, no serious complication may occur, but if *total* the lens may come forwards into the anterior chamber and interfere with drainage of aqueous through the canal of Schlem, or it may pass backwards into the vitreous with escape of this material forward into the anterior chamber, with the same result. Hence in total dislocation secondary glaucoma will follow almost certainly. If the lens in the anterior chamber has not been present in this situation long enough for adhesions to form between it and the iris, it may be removed successfully, but such an operation is liable to be followed by prolapse of vitreous, an irritable eye, and a secondary rise of intraocular tension, resulting in loss of sight.

Dislocation of the lens produces changes in the depth of the anterior chamber; and in backward and partial dislocation, iridodonesis from loss of iris support.

Pigment deposits upon the anterior surface of the lens may be congenital or acquired. The congenital deposits are due to remains of pupillary membrane. These are very fine dots situated in the central part of the anterior surface, and sometimes accompanied by strands which pass from the centre of the lens surface to the anterior surface of the iris, being attached just external to its free edge.

The acquired variety is derived from the pigmented posterior surface of the iris, and results from posterior synechiæ which have broken down. Other synechiæ are generally present (rendered more visible by dilatation of the pupil). Acquired pigment deposits are much coarser and have not the dot-like character of vestiges of pupillary membrane. They are evidence of old iritis.

Cataract. Changes in the crystalline lens, with alteration of its translucency and diminution of vision in the affected eye, occur from various causes at different ages. The varieties of cataract may be grouped as follows :—

(A) *Congenital cataracts :* Discoid, lamellar, blue dot, posterior polar.

(B) *Traumatic cataracts,* from perforating or concussion injuries : Anterior capsular, diffuse, posterior cortical.

(C) *Inflammatory cataracts,* from degenerating changes accompanying iridocyclitis, detachment of the retina, and retinitis pigmentosa.

(D) *Nutritional cataract,* complicating diabetes.

(E) *Idiopathic cataract :* Primary senile.

A cataract in patients under thirty-five years is said to be " soft " ; after that age " hard." If occurring as a primary condition, the lens changes are usually bilateral, although further advanced in one eye than in the other; but if secondary to some local condition in the eye itself the changes are nearly always unilateral, the other eye may show lesions in the fundus.

(A) Congenital Cataract. 1. *Lamellar cataract* is probably associated with abnormal calcium metabolism and the parathyroid glands. Upon normal calcium metabolism depends the development of such structures as the teeth, the bones, the crystalline lens, and the central nervous system. In many cases of lamellar cataract the enamel of the teeth is poorly developed, and there is often a history of " convulsions " in infancy (after an attack of convulsions the amount of calcium salts present in the brain is reduced to half the normal). The ring-shaped lens opacities seen in cases of lamellar cataract consist microscopically of (*a*) granules containing substances of different refractile index from that of the surrounding lens ; (*b*) cracks from shrinkage of the normal lens material. On the inside of the ring the opacity fades gradually away, while on the outside the boundary is sharp. The cause of maldevelopment was, therefore, of gradual onset but sudden termination. " Riders," only seen on the outside of the rings, are thought to indicate attempted recurrence. The opacities may be multiple, two or more concentric rings being present. A knowledge of the age of the rings may be obtained from the consideration of their size. Are they always of intrauterine formation ? The diameter of the lens at birth is 5·75 mm. The diameter of the zones of opacity vary from 3 to 6 mm. Hence the largest of them are formed after birth. The enamel of the teeth, which is developed in the ninth month, is sometimes quite good in cases where the zone of opacity is small and central, but where the zones are large the enamel is defective. Is lamellar cataract due to rickets? It has been determined that where rickets is rare cataract is rare, but on examination of 5,000 rickety children lamellar cataract was found in only four instances. Rickets is now thought to have nothing to do with the onset of lamellar cataract.

Is the cataract toxic in origin? When pregnant rabbits are fed on naphthaline it is found that the young rabbits exhibit central lens opacities which, when once formed, remain stationary, even if the naphthaline is only given for a short period. This may have some bearing on the occurrence of "*discoid*" *cataract*, a rare congenital malformation of the lens, in which single central semitransparent opacities are present with sharply-cut outlines, which may be large or small, while the rest of the lens substance is usually free from defect.

2. *Blue-dot cataract* is usually an accidental discovery in the course of clinical examination. The opacities produce very little effect upon the visual acuity. They are small, of irregular shape, and distributed throughout the lens substance. Their depth can be appreciated easily with the binocular loupe.

3. *Posterior Polar Cataract.* This opacity is situated at the posterior pole of the lens and results from the persistence of the anterior portion of the hyaloid artery, which normally in fœtal life passes forwards from the disc through the vitreous to impinge on the lens, upon the posterior surface of which it gives off a series of branches. The hyaloid artery and its branches should be entirely removed during development.

(B) **Traumatic cataract** may show itself in three forms:—

1. *Anterior capsular cataract* is associated with a corneal lesion. It may follow a perforating wound or result from a corneal ulcer.

In a penetrating injury, the instrument having penetrated for a short distance into the lens substance, the effect of this upon the lens varies with its depth and with the age of the patient. If the lesion is superficial and localised, only a small opacity of the anterior surface may result, but if deep with laceration of the anterior lens capsule, especially when occurring in a child, aqueous will diffuse between the soft lens fibres and rapidly produce a diffuse cataract. Further, the fibres may swell, bulge forward through the rent in the capsule, and produce secondary glaucoma from blocking the angle of the anterior chamber. In adult life the chamber is deeper and the lens harder, so that diffuse change in it is less likely to occur.

Corneal ulcers, especially those occurring in the course of ophthalmia neonatorum, are liable to perforate. The anterior surface of the lens is thus brought in contact with the ulcer, and temporarily forms part of its base. When the anterior chamber reforms, some of the exudate which closed the base of the ulcer is found to remain adherent to the anterior surface of the lens. These white spots persist, and provide evidence that the cornea has at some time been perforated.

2. *Posterior cortical cataract* appears in cases where the eye has received a severe blow. The normal relationship between the posterior lenticular surface and the anterior surface of the vitreous is altered, and a branching, tree-like opacity radiating in all directions from a central point, and reaching in some cases to the lens periphery, may be seen. These traumatic posterior cortical opacities tend to interfere with vision less than do the posterior polar ones of congenital origin and often disappear after a short interval.

3. *Diffuse traumatic cataract* may develop with or without perforation. In

the former instance evidence is usually to be found. A corneal scar, or perhaps a visible tear in the iris, may be present. These should be visible by oblique illumination with the lens and loupe both before and after dilating the pupil.

Even if no evidence of perforation can be found, the mere presence of a traumatic cataract raises the question of a **foreign body within the eyeball**, and this must be settled if possible. If an X-ray picture is obtainable, this should be localised. If there is a chance of a magnetisable foreign body being in the eye, the magnet should be used to supply evidence of its presence and assist in its removal. The principles governing the use of this instrument are two: (1) the giant magnet is used to bring the foreign body from the vitreous or lens into the posterior chamber behind the iris, and thence around the iris, through the pupil, into the anterior chamber, thus converting a complicated into a simple case; (2) the small hand magnet, used through a properly planned corneal incision, will bring the body from the anterior chamber out of the eyeball. If a small magnetisable body can be localised by X-rays or be seen in the vitreous chamber, the small hand magnet may be introduced, directed into the eyeball through an appropriately planned scleral incision and the foreign body removed directly from the eyeball through this. Damage to the lens and anterior ocular structures may thus be avoided. A magnetisable foreign body will be indicated by considerable pain being produced when the magnet is brought near to the globe, the piece of metal being pulled forward with the inflamed structures in which it is embedded. Hence the smallest magnet should be used first, and the approach toward the eyeball should be slow and deliberate, so that unnecessary injury is not inflicted. Absence of all pain when the giant magnet is brought close to the eyeball while the patient looks up and down and to the right and left negatives the presence of a magnetisable foreign body, unless this is very small or has been present for so long as to be entirely embedded in the tissues. If the foreign body is left in the eyeball without removal being attempted, the eye is eventually lost in most cases as the result of—

(*a*) Panophthalmitis.
(*b*) Chronic iridocyclitis and siderosis.
(*c*) Shrinkage of the eyeball.

Siderosis results from staining of the internal structures of the globe by the diffusion of the rust particles by leucocytes in the case of an iron foreign body. An eye so left may become a danger to the remaining useful one. Successful removal of an intraocular foreign body much increases the chances of saving the injured eye, but the ultimate results in these cases are not good as regards acuity of vision. Detachment of the retina and macular changes frequently intervene in an apparently successful case.

(C) **Inflammatory Cataract.** The importance of this condition is the recognition of its being secondary, and not due to primary idiopathic or nutritional change in the lens.

In cataract arising secondarily as the *result of iridocyclitis* an examination of the cornea of the affected eye will reveal keratitis punctata. The iris also may be discoloured or atrophic, and synechiæ may enlighten the observer. No opinion should be given until a thorough examination of *both* eyes has been carried out in every case of monocular cataract. Lens changes should be looked for in the other eye after the pupil has been dilated. and if these are not found the cataract should be regarded with suspicion as being secondary to either trauma or degenerative changes in the globe. Monocular cataract, arising from whatever cause, should never be operated upon while the sight of the second eye remains good except under three conditions:—

(1) When the patient's condition renders him a danger to himself by limiting his field of vision to one side by 35 degrees (see p. 284). (2) When the cataract renders him a danger to others for the same reason. (3) When he is so sensitive to his altered appearance and disabilities as to refuse to live his normal life. If in a case of monocular cataract the eye becomes painful either from increased tension or chronic iridocyclitis, it becomes "a blind and painful eye," and should be removed.

Posterior Cyclitic Membrane. In cases of chronic iridocyclitis an inflammatory membrane may form behind the lens in the anterior part of the vitreous from the exudates of the inflamed ciliary body. This prevents any view of the fundus or any sight being possible. It is analogous to the inflammatory exudates which may be thrown out by the iris and block the pupillary gap.

(D) and (E) **Diabetic and senile cataract** may be considered together. The condition arises almost always bilaterally, a series of radial opacities, like the spokes of a wheel, appearing, usually in the posterior cortex of the lens first, and being frequently accompanied by changes in the nucleus. The opacity is often more advanced in one eye than in the other, the vision in the one most affected being considerably reduced before the patient presents himself for treatment, the real reason for his arrival being the failure of the second eye. On examination with the lens and loupe a greyish or reddish reflex is obtained from the partially opaque crystalline lens, but a cataract should not be diagnosed on this alone. A greyish reflex is given by many senile lenses without opacity being present, and the greenish reflex of the lens in glaucoma (with greatly reduced vision occurring in old people) is sometimes mistaken for cataract. On shining the light obliquely on to a cataractous lens which is not mature (*i.e.*, in which the posterior part only is opaque) *a shadow is cast by the iris* upon the posterior opacity. This shadow is not found in a fully mature cataract in which the anterior part of the lens, lying immediately behind the iris, has become opaque.

Treatment. In a case of cataract the history must be taken, the pupil reactions to light and accommodation ascertained, and *both eyes* systematically investigated in the dark room under a midriatic, first with the lens and loupe, and then with the ophthalmoscope, noting the state of the cornea, iris, lens, vitreous and retina, and the condition of both conjunctival and lacrimal sacs. A clinical examination of the urine and cultures of the conjunctival sacs for organisms complete the data upon which the question of extracting the cataract should be considered from three points of view: (1) Will the operation kill the patient? (2) Will the operation result in loss of the eye? (3) Will the sight be regained if the operation is successful?

(1) Will the operation kill the patient? Age is important, the subject being as old as his arteries. The health of the heart, lungs and kidneys is also vital. The cataract patient has to remain upon his back with both eyes bandaged for four days, considerable self-restraint being necessary during a somewhat trying ordeal. The cardiac and vascular system can be estimated quite simply by the patient's colour and pulse, and presence of shortness of breath and œdema of the lower extremities. The health of the kidneys is to be gauged by the examination of a specimen of urine for albumin and sugar, and by poor appetite and drowsiness during the day associated with mild delirium and sleeplessness at night. Thirst, a dry, furred tongue, and a

skin which is harsh, combined with nocturnal frequency of micturition, are danger signals. Sugar and diacetic acid in the urine indicate the possibility of retinal change behind the cataract and the liability to coma, which is always increased by the worry and mental stress of an operation. If sugar and breakdown products are present, treatment should be carried out to improve the condition before the operation is attempted. No "renal function tests" other than clinical ones are necessary. Chronic bronchitis, obesity, and cough that lasts throughout the winter, if occurring in a patient who is to be kept lying on the back, will result in hypostatic pneumonia (unless extreme care is taken), with a rapid lethal exit.

(2) Will the operation result in loss of the eye ? This will depend upon its external and internal condition, and the sterility or otherwise of the lids, conjunctival sac and lacrimal passages. The presence of the pneumococcus or streptococcus negatives operation; the staphylococcus aureus is dangerous, but the "albus" variety need not prevent operation if the conditions are favourable. The important internal condition is the state of health of the uveal tract; anterior or posterior synechiæ, "k.p.," a high degree of myopia with floating vitreous opacities in the remaining eye pointing to fluidity of this structure, make the operation more difficult. Glaucoma almost negatives any attempt at extraction of a cataract. Frequent coughing may cause prolapse of the iris or an expulsive intraocular hæmorrhage in an eye from which the cataract has been extracted. And chronic septic conditions elsewhere (pyorrhœa alveolaris) easily may spoil a perfectly successful case. Lastly deafness, exophthalmos, or any other abnormal condition may increase very much the difficulties of the operation and after-treatment.

(3) If the operation is successful, will sight be regained ? An opinion can be given on this point after examination of *both* eyes, special attention being given to the following points :—

History. Could the patient ever see well with the affected eye ? Did it ever squint ? (When an eye becomes blind from cataract, and much error of muscle balance is present, a squint may develop.) Before the present difficulty, which was the better eye of the two ? Has the eye suffering with cataract ever given trouble previously ?

Oblique Illumination with the Lens and Loupe. Are there opacities in the cornea or evidence of old vascularisation ? Is there any congenital abnormality of the iris ?

The Opposite Eye. Is the vitreous clear ? Is the fundus normal centrally and peripherally (especially the macula) ? If changes are present in one eye, they are probably present in the other.

Projection. The patient, while in the dark room, is asked to cover the good eye, and the light is placed directly above the head, the other lights being obscured. The surgeon reflects light upon the affected eye by the ophthalmoscope mirror from various directions (above, below, from the right and left) while the patient looks steadily in front. She should be able to define accurately the direction from which the light appears to come; she must not look at the light. If the peripheral sense of movement and direction is retained, the peripheral retina is normal and no detachment of the retina or large patch of atrophy is present behind the cataract. Unfortunately, very little information is provided of the sense of form present in the central retina, and it is the presence of macular changes that so often gives poor visual acuity after quite successful extraction. Some idea of the condition of the macula can be obtained by examining the patient's colour perception. The surgeon reflects light upon the affected eye by the ophthalmoscope mirror while the patient looks straight into it. Across the beam of light are inserted red and green glasses alternately. If the patient readily distinguishes the presence of these it can be hoped that there is no central scotoma due to macular changes.

The operative treatment of cataract is affected by the age of the patient.

(*a*) Before the age of thirty-five years the cataract is "*soft*"; upon incision of the capsule the lens is found to be of a semi-fluid consistency. Further, it is known that the action of the aqueous upon the lens fibres makes them swell and become opaque, and finally partially absorbed. In the lamellar cataracts of young people in which operation is decided upon the following procedure is carried out. It must be remembered, however, that the question whether the patient's vision after the operation with the high plus spheres which it will then be necessary to use, is likely to be better than before the operation with his lens opacities, must be considered. If he sees less than "counting fingers" with both eyes, he should be operated upon, but while he sees 6/18 with each eye it is wiser to avoid surgical interference. There remains a margin of cases in which the surgeon's skill will influence his judgment, but in any case the more affected eye should be treated first. The method of treatment is to remove the lens in two stages—discission and curette evacuation.

Discission. The capsule of the lens is incised with a Zeigler's knife, the patient (if young) being under a general anæsthetic and the pupil widely dilated. Slight separation of the edges of the wound is allowable, but *the lens material should not be lacerated.* In this operation little aqueous should be lost. The eye should be bandaged and the pupil kept dilated. Aqueous will permeate the lens fibres exposed to its action, causing them to swell and present through the wound in the capsule and pass into the anterior chamber. During this stage the eye must be under observation. Drainage through the angle of the anterior chamber may be obstructed by the lens matter causing secondary glaucoma.

Curette Evacuation. The anterior chamber is opened with a keratome by an incision through the periphery of the upper quadrant of the cornea, and the lens material evacuated with a curette and irrigation of the chamber with warm normal saline. Finally the iris is replaced, if necessary, so that the pupillary gap is round and central. As the aqueous reforms it will continue its action upon the remaining lens fibres and a good gap eventually will be obtained, when the appropriate spheres can be prescribed.

(*b*) If the patient is over thirty-five years of age the nucleus of the lens is "*hard*," and may be extracted entire. In elderly persons almost the whole lens will come away without leaving any soft lens matter behind. At intervening ages varying amounts of soft lens material will be present.

Extraction of Senile Cataract. Local anæsthesia by 4 per cent. cocaine will suffice. The pupil should be under atropine and the lids held apart by Lawford's speculum. The surgeon, standing behind the patient and *facing towards* the eye upon which operation is to be performed, holds the eye with fixation forceps and makes a corneal incision with a Graefe's knife. The point enters at the corneoscleral junction on the temporal side at a point corresponding to ten o'clock on the nasal side corresponding to two o'clock for the right eye. For the left eye the incision is commonly made from the temporal side with the surgeon's left hand. At the same time that the point of the knife makes exit *inwards*, it must be made to cut *upwards*. As much of this upward incision as possible should be completed in the first sweep of the knife, before the whole of the aqueous escapes, the eye being drawn forwards out of the orbit upon the edge of the knife. In this way the surgeon avoids wounding the iris. The incision is completed in two or three sweeps of the knife; while the incision is being made the hand holding the fixation forceps *must not press* upon the eyeball. A small portion of conjunctiva should remain attached as a "flap" to the upper margin of the corneal incision. At this point the speculum may be removed. The lens capsule is next incised with a cystotome introduced into the anterior chamber, a circular peripheral cut being combined with a central longitudinal one. To deliver the lens the patient is asked to look down, and pressure is made backwards upon the lower edge of the lens through the wall of the globe at the lower corneoscleral margin with a curette. The upper edge of the lens is thus tilted forwards, the corneal wound gapes, and the lens gradually passes through it, carrying the iris before it. At the last stage of the operation this structure is replaced with the iris repositor. Some surgeons combine extraction of the lens with a complete or peripheral iridectomy. After the operation a drop of atropine is instilled and both eyes are bandaged. The eye should be dressed daily ; the second eye may be uncovered upon the fourth, and the one operated upon on the tenth day in an uncomplicated case, the patient leaving the ward in a fortnight.

Discission of the Lens capsule is frequently necessary at the end of about six weeks after extraction of a senile cataract. A simple incision should be made through the capsule with a Zeigler's knife. The knife should be introduced into the anterior chamber, made to pass through the capsule, and across the eyeball close behind it without entering the vitreous. The cut should then be made in the capsule from behind forwards. Only one thing need be said—many perfectly successful cataract extractions are ruined by the discission or " needling " operation which follows them (see p. 271).

Diseases of the Vitreous. Changes in the vitreous may be due to congenital abnormalities, to trauma or inflammation.

(*a*) *Congenital :* The vitreous may contain remnants of the hyaloid artery. This remnant may be complete, arising from the vessels in the centre of the optic disc, crossing the vitreous as a band, and being attached to the posterior surface of the lens. Its anterior or posterior part may be present alone as a floating vitreous strand. Most commonly an opacity only remains upon the posterior surface of the lens (posterior polar cataract) at the point the hyaloid artery originally reached it and divided into its terminal branches.

(*b*) *Traumatic :* As the result of a blow upon the eye or a spontaneous hæmorrhage from an arteriosclerotic retinal vessel the vitreous may be filled with blood. This may be seen by oblique illumination with the lens and loupe as a reddish opacity behind the crystalline lens and also by direct ophthalmoscopy with the small plane mirror as large black, ragged, floating vitreous opacities against the red fundus reflex, if this can still be obtained.

(*c*) *Inflammatory :* A cloud of fine vitreous opacities indicates an unhealthy condition of the posterior uveal tract (the ciliary body and choroid) and is often a discovery of great importance. A smaller number of larger opacities are visible in the later degenerate stages of choroiditis or of myopia and in detachment of the retina, or refractile floating opacities may be seen.

Floating vitreous opacities indicate a change in the consistency of that body. In degenerate conditions (high myopia) a curious single tethered " ring " opacity may be seen floating in the vitreous. The explanation of such a phenomenon is that the hyaloid membrane surrounding the vitreous body has become partially detached, possibly at the disc where a crescent indicates the presence of considerable stretching. Between an intraocular growth and inflammatory mass the diagnosis is not always clear. In such cases the absence of vitreous opacities and other evidences of inflammation may be important as being distinctly in favour of neoplasm.

DISEASES OF THE RETINA

The nervous mechanism of the eyeball does not form a complete internal coat for it. Extending forwards from the ora serrata, it becomes continued over the inner surface of the ciliary body (pars ciliaris retinæ) and iris (pars iridica retinæ), finally coming to an end at the pupil margin. The retina consists of the anterior and posterior walls of the primitive optic vesicle infolded to form the two layers of the optic cup, the anterior layer being evolved into the retinal nerve elements while the posterior retains much more nearly its original condition, forming the outer pigment layer of the retina. In detachment of the retina the original cavity of the optic vesicle is restored, and fluid collects between the inner nerve elements and the outer pigment layer. "Detachment," therefore, is a misnomer.

The retina should be divided into three areas, which must be examined separately for a full report upon this structure to be made: the optic disc—the macula—and the periphery.

(I.) **The optic disc** should be seen first; it enables the surgeon to orient himself in the fundus, and in itself sometimes provides useful information. In connection with it six matters should be investigated, the names of which begin with the letter "C."

1. *Colour:* Note that this varies with the experience of the surgeon, the type of light used, and the patient. The surgeon may not be sure what does constitute "atrophy"; a wire filament lamp will give a whiter appearance than a carbon filament, and some patients have normal discs which are considerably paler than those seen in others. In any case there is too much variation to be certain, and it is wiser to record "pallor" rather than "atrophy" unless one has a chart of the fields of vision showing some abnormality, and a note of lowered visual acuity.

2. *Circulation:* The conditions of the arteries and veins should be examined and pulsation noted, and also the presence of hæmorrhages or exudates. In arteriosclerosis the arteries show an appearance of being made of gold or silver wire and may press strongly upon the veins as they pass in front of them. At this point a hæmorrhage is often seen. In advanced cases of arteriosclerosis the arteries may be so reduced in calibre as to be hardly visible, while the veins become distended, darkened and tortuous. In primary optic atrophy and embolism of the central retinal artery (see p. 276) the arteries and veins are much reduced in size, while in secondary optic atrophy the vessels are not much altered.

In thrombosis of the central retinal vein "choked disc" occurs in which numerous hæmorrhages are present and the veins are much distended.

Swelling of the disc occurs in two quite distinct conditions: (*a*) *Neuro retinitis*, in which the disc takes part in a general retinal inflammation where the swelling is only moderate (two dioptres). (*b*) A *papillœdema* or swelling localised to the disc due to increased intracranial pressure in which the swelling may be much greater (eight dioptres). The swelling of the disc may be measured by comparing the lenses that it is necessary to place between the observer's eye and the small concave mirror of the ophthalmoscope to enable him to see plainly (1) the general retinal surface, and (2) the summit of the swollen disc (3D. = 1 mm.).

Pulsation of the veins of the disc is commonly seen and is of no pathological significance. Pulsation of the arteries is pathological, and is found in chronic glaucoma and aortic regurgitation.

3. *Circumference:* In secondary optic atrophy, following neuro-retinitis or papillœdema, the edges of the disc are badly defined. In the primary optic atrophy of tabes they are sharply cut.

In cases where the disc is swollen from whatever cause clearness of definition is lost. A condition frequently seen in highly hypermetropic eyes is sometimes a pitfall in diagnosis. Here, in spite of the appearance, no swelling is present (pseudopapillitis).

4. *Crescent:* In congenital deformity of the disc a pale crescent is to be seen usually in the lower part of the disc, but occasionally in other positions. Its presence indicates that the acuity of vision in the eye in which it is present will probably be low. In some cases the usually circular disc may be reduced to a slit through which the vessels pass (Fuch's coloboma).

Acquired deformity of the disc occurs in myopia of the progressive type Here increase in the size of the eyeball occurs, specially to the temporal side of the disc at the posterior pole of the eyeball (posterior staphyloma) with the result that the choroid and retina which do not stretch are no longer able to cover the underlying sclera in this region, which becomes visible in a crescentic area at the side of the disc. This condition varies with the myopia and may give a useful measurement of its progress, and its width always should be recorded in terms of " disc diameters."

5. *Cup:* This appearance at the disc may be physiological, pathological or atrophic.

A *physiological cup* is frequently found. Its edges do not reach near the edges of the disc, it being confined to the point where the retinal vessels appear. It is not associated with glaucoma and is compatible with a perfectly healthy eye.

A *pathological cup* is found in chronic glaucoma ; the edges of the cup reach to the edges of the disc, which even may *overhang* the cavity as seen by the course which the retinal vessels take within it. Pathological cupping is not incompatible with almost full vision, but is associated almost always with reduction of the nasal field of vision or crescentic enlargement of the blind spot, the points of the cresent converging upon the fixation point. A suspicion of pathological cupping should lead to immediate investigation of the fields of vision, centrally and peripherally.

An *atrophic cup* is seen in primary optic atrophy (tabes). The disc becomes hollow by reason of the wasting of the nerve fibes, and a perforated plate (the lamina cribrosa) becomes visible at the bottom of the cup. In secondary optic atrophy the cup is filled in by new fibrous tissue.

6. *Curiosities: Coloboma of the disc* resulting from imperfect closure of the cleft formed in the primitive optic cup by the entrance of the central retinal artery, may be found or remnants of the hyaloid artery springing from the disc, while abnormal arrangements of vessels or myelinated (opaque) nerve fibres may be present.

(II.) **In the macular region :** The *fovea centralis* is specially developed for the central perception of form. The cones are numerous and well exposed by a pushing aside of the retinal elements internal to them. Hence the underlying coat is here often very visible. This is specially brought out in embolism of the central retinal artery where the whole macular region is pale, but the fovea centralis shows as a " cherry red spot " owing to the vascularity of the choroid beneath. The macula is specially liable to trauma, metastatic infection and arteriosclerotic changes, and disease may be present here when absent elsewhere in the retina. A star-shaped figure at the macula is produced by retinal effusion of fluid by which the membrane is thrown into a series of folds radiating from the fovea. A crystal of cholesterine sometimes marks the position of the macula, at other times there is no indication of its exact site. Cracks or splits may appear at the macula in progressive myopia, and, after severe injury, concussion changes (fine pigment dots) may become visible in this region.

(III.) **Peripherally** : The retina is developed to detect movement and the position of objects. It may give evidence of old trauma by the presence of a choroidal rupture, a patch of proliferative and atrophic scarring in the periphery or a detachment of the retina. Long-standing inflammation may be evidenced by patches of choroido-retinitis where proliferation of pigment and atrophy of the choroid take place to varying extents (see pp. 256—258).

Retinitis pigmentosa, a degenerative condition, may be found. In this pigment-spots of spider-like shape (like bone corpuscles) may occupy an intermediate zone between the centre and extreme periphery of the fundus. Posterior cortical lens opacities and floating vitreous opacities usually accompany a pale disc of waxy appearance and the characteristic pigmentation to make up a clinical picture which, if once seen, can be recognised easily.

Detachment of the retina occurs centrally and peripherally. It may be spontaneous or follow trauma or inflammation, especially in myopia—both often contribute a quota to this result. In a part of the fundus a darker red reflex is obtained, and on ophthalmoscopy this area is seen out of focus when the rest of the retina is examined. By putting up plus lenses before the observer's eye, the detached portion can be clearly seen and its displacement forwards measured. It is seen to be thrown into folds and altered in colour, its vessels being tortuous, smaller and darker in hue than usual. A detached retina necessarily results in alteration of the visual field in the area detached (see p. 290). Wherever the retina is first affected the part which eventually tends to become detached is the lower quadrant. If the retina has become detached as the result of trauma or inflammation three things may be visible : (1) A tear can be found in some part of the detached portion. (2) A patch of old choroidal or retinal disease will be present. (3) Vitreous floating opacities can be seen with the small plane mirror and about a plus 7 D. lens. If none of these are present one is forced to the conclusion that the detachment has occurred spontaneously. The most important cause for spontaneous detachment is *intraocular neoplasm* either of the retina or underlying uveal tract. The presence of such a neoplasm may be rendered obvious by trans-illumination of the sclera.

Treatment. The prognosis of detachment of the retina has been much improved by the development of a technique by which a single hole in the retina, visible in cases of detachment, can be located upon the outside of the eyeball and closed by evacuating the sub-retinal fluid and producing a localised choroiditis around it by which it is rendered adherent to the underlying sclera. If more than one hole, or a long tear, is present the prognosis is not nearly so good.

Glioma of the retina is a condition which occurs in young children under the age of seven years. It tends to be bilateral and to become fatal by local recurrence. The whole of the retina is replaced by white fibrous tissue, and abnormal vessels are present. On shining a light into the child's eye a whitish reflex is obtained instead of the usual red one. From this a *pseudoglioma* must be distinguished. Here there is no age limit and the condition does not tend to be bilateral or fatal. Pseudoglioma is inflammatory in origin, and hence the cornea should be examined for keratitis punctata, the iris for synechiæ, and the vitreous for floating opacities. Further evidence may be found in the choroid and retina of the sound eye. On the finding of signs of inflammation the diagnosis can be made before the eye is removed, but usually it is not certain enough to be relied upon without a microscopic examination of the tumour.

Hæmorrhagic and serous exudates are seen in the retina in diseased conditions of the arteriovascular system, in increased intracranial pressure, and in renal disease. A curious collection of refractile spots is to be found at the macular region in some cases of diabetes. Examination of the fundus oculi is, therefore, frequently of value in diagnosis. *Retinitis* found in cases of nephritis, even when other evidence of renal failure is slight, seriously adds to the gravity of the prognosis. It is thought that such a case is within three years of exitus lethalis. Retinitis occurring in the course of eclampsia is of less serious import. With emptying of the uterus the condition will improve and the retina will be liable to further injury only with recurrence of pregnancy. Central refractile deposits in diabetes do not appear to affect the prognosis very seriously, but their presence may have marked effect on the visual acuity after the removal of a diabetic cataract.

GLAUCOMA

Glaucoma, a condition in which the intraocular tension is raised above normal, may be primary or secondary. When primary it is either congenital or acquired, when secondary it complicates trauma, inflammation or new growth.

To **primary congenital glaucoma,** occurring in children, the term *buphthalmos*—" ox-eye "—is applied. The condition is due to the absence of the spaces of Fontana, normally present at the corneoscleral junction in the angle of the anterior chamber. These spaces provide for the percolation of aqueous from the interior of the eye and its absorption into the canal of Schlemm, one of the deep scleral veins in this neighbourhood (see p. 251). In buphthalmos the anterior chamber is deep and the eyeball increased in size. The sclera is thin from stretching by the increased intraocular tension, and the bluish colour of the choroid coat becomes visible through it. In adults increased tension produces no such effect (compare hydrocephalus in the child and the adult). Buphthalmos is usually, though not always, bilateral, and it is in most cases easily recognised.

Primary acquired glaucoma occurs in a well-known type of eye—one that is small and hypermetropic, with a relatively small cornea and shallow anterior chamber. These structural variations affect the anatomy of the angle of the anterior chamber, and predispose to an attack of glaucoma, by making the drainage of aqueous more difficult. Amongst the exciting causes may be recognised :—

(*a*) *Middle age :* The lens increases in size from birth to old age. The oldest epithelium, being in the centre of this structure, cannot be shed, and the gradual increase in the size of the lens, due to the growth of the cortical epithelium, tends to push the iris forward and obstruct the angle of the anterior chamber.

(*b*) *Sepsis :* By some considered a very important cause. The trouble may arise from the gastro-intestinal tract (teeth and tonsils), the respiratory tract (nose and accessory sinuses) or from septic conditions elsewhere.

(*c*) *A life of work for the ciliary muscle :* necessitated by modern conditions. Much clerical work is specially serious in hypermetropic eyes, as it leads to hypertrophy and congestion of the structures of the ciliary region, and further embarrassment of this already small and crowded part.

It has been stated that sepsis and overwork tend together to produce a condition of fibrosis in the ciliary region, the result of a "subinfection," and comparable with arteriosclerosis.

(*d*) *Midriatics*—improperly used: Last of the exciting causes of primary glaucoma, and very important because it can be prevented. Midriatics are used to dilate the pupil for examination of the fundus or retinoscopy. After thirty-five years of age atropine should never be used for this purpose, and homatropine and cocaine only when the intraocular tension has been examined and found to be normal, and when eserine is used to contract the pupil on completion of the examination.

Secondary glaucoma may complicate trauma, inflammation or neoplasm.

(A) *Traumatic.* (1) *Injury of the iris* and effusion of blood from it into the anterior chamber—a hyphæma—often follow a blow upon the eye. This blood is usually small in amount, and collects at the bottom of the chamber. If, however, the effusion be large or repeated it may fill the chamber, and so obstruct the spaces of Fontana arranged around its circumference, giving rise to increased intraocular tension. Hyphæma is, however, seldom complicated by glaucoma; much more commonly the tension is lowered owing to the depressed activity of the ciliary body following the trauma. In cases where blood is present in contact with the posterior surface of the cornea for a fortnight or more, especially with raised intraocular tension or an injured Descemet's membrane, the cornea is liable to become stained by the blood (Fig. 88). This staining may persist long after the blood has been absorbed, and has been mistaken for the lens dislocated into the anterior chamber—another result of trauma, and cause of glaucoma.

(2) *A hæmorrhage into the vitreous* may result also from a blow upon the eye, and this, if large, will lead mechanically to glaucoma by suddenly increasing the actual contents of the globe.

(3) *Dislocation of the lens* into the anterior chamber is an accident which is extremely liable to be complicated by glaucoma—especially in old persons where the lens is large or in highly hypermetropic eyes where the anterior chamber is small and shallow. The edge of the lens, lying in its abnormal position in front of the iris, obliterates a large arc of the circumference of the chamber, and so a considerable proportion of the spaces of Fontana are put out of action. The liability to glaucoma is further increased by escape of vitreous (and exudate from the injured iris) which are only too likely to follow the lens into the already embarrassed chamber.

(4) *Thrombosis of the central retinal vein*—rarely the result of trauma, more often of a metastatic inflammation elsewhere—is only occasionally followed by glaucoma. The explanation of this variable result is obscure, but it probably lies in the amount of blood which continues to flow through the central retinal artery, and further depends upon partial re-establishment of the circulation through the retinal veins.

(5) *Intraocular surgical operations* may be complicated by rise of intraocular tension. This serious condition results from (*a*) escape of vitreous into the anterior chamber, (*b*) entanglement of the iris or lens capsule in the wound, with resulting chronic iridocyclitis, and secondary inflammatory glaucoma. Vitreous, as it lies in the chamber, tends to block the spaces of Fontana and so increases the possibility of difficulty occurring with the necessary drainage of aqueous through them. As this complication ruins the function of an eye after an otherwise successful operation, all possible steps to prevent its occurrence should be taken. Certain suggestions can be made which the student should verify from his own clinical experience.

Firstly, the value of simple extraction of the lens for cataract. Here no iridectomy is done, and the iris, remaining intact, helps to keep back vitreous and lens capsule from the wound, while the pillars of the coloboma of the iris produced by operation, which may become entangled in the scar, are avoided altogether.

Secondly, the dangers of needling operations. Here the capsule of the lens, which is holding the vitreous back in place, is incised and the vitreous thus encouraged to invade the chamber. The aperture made in the capsule should be central and not too large. No stirring up of the vitreous should occur. The needle or Zeigler's knife which is used should pierce the capsule first, and then incise it *from behind forwards* towards.the cornea (not from before backwards into the vitreous). Finally, the operation should be performed simply and rapidly (or a chronic cyclitis, with a cloud of vitreous opacities, will result from the trauma), and should be treated with all the honours of a major operation and not with the contempt of a minor procedure.

(B) *Inflammatory. Secondary glaucoma following inflammation* is probably much more common than is generally recognised, many of the so-called "primary" cases coming into this group. Eyes suffering from chronic iridocyclitis may be very free from evidence of inflammation, and yet changes may occur in the iris and in the angle of the anterior chamber which gradually embarrass the escape of aqueous from the eye, culminating in what appears to be an attack of acute glaucoma.

(1) *In the Iris.* Synechiæ occur at the central free edge to the lens capsule and at the peripheral attached margin to the membrane of Descemet upon the posterior surface of the cornea, here in close relation with the iris. If the iris becomes attached to the lens capsule along the whole of its free edge a total ring synechia results, the pupil becomes secluded, and iris bombé follows, with secondary glaucoma, unless relieved. If the iris becomes adherent peripherally to the membrane of Descemet upon the posterior surface of the cornea, the spaces of Fontana are shut off from the aqueous and a "false angle" is produced in the anterior chamber. It is not necessary for this false angle to be present throughout the circumference of the chamber; enough spaces of Fontana need only be obliterated to reduce the amount of aqueous which can be drained away below the amount normally secreted in a given time.

(2) *In the Spaces of Fontana.* As the result of the constant percolation and absorption of the altered aqueous secreted by an inflamed ciliary body, the spaces of Fontana become obstructed by new-formed fibrous tissue and the venous channel of Schlem becomes sclerosed.

Hence the escape of aqueous is made difficult at three different positions, and the balance of drainage over secretion approaches nearer and nearer to the dangerous limit.

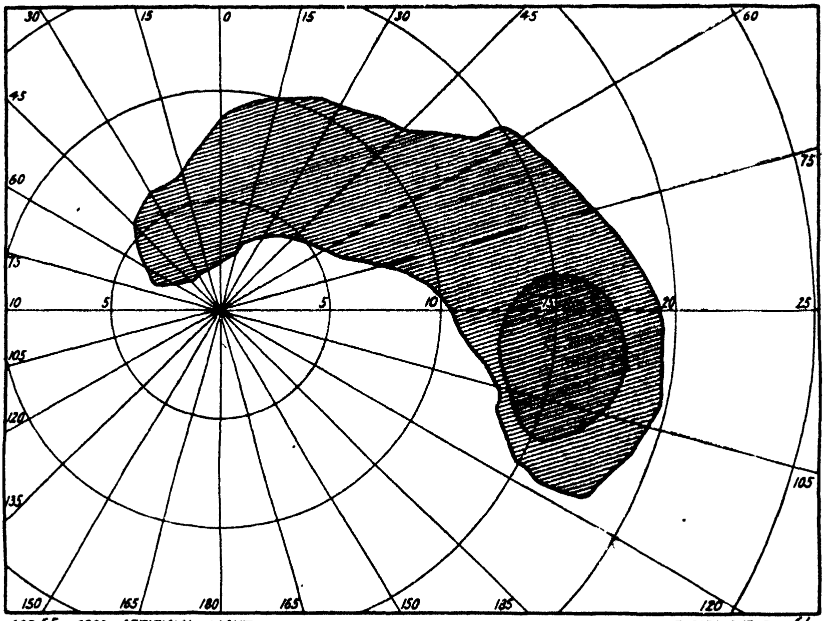
(C) *Glaucoma following Neoplasm.* A neoplasm, if intraocular, shows three stages of progress: (*a*) the stage of silent unobtrusive growth; (*b*) the stage of raised intraocular tension; (*c*) the stage of orbital invasion. Hence if the eye is removed in the glaucomatous stage the patient should be safe, but unfortunately, especially in the more malignant melanotic varieties, there is no sharp dividing line between the three stages.

Clinically glaucoma may be acute or chronic.

Acute glaucoma is associated with extremely severe supraorbital pain and vomiting. The eyeball is congested, this being due to distension of the perforating anterior ciliary veins, and the anterior chamber is shallow.

Chemosis of the conjunctiva is usually present, and may even be accompanied by œdema in the orbit, giving rise to proptosis of the eyeball. The vision of an eye affected by acute glaucoma may be "no p.l." The cornea is "steamy," and the pupil, seen indistinctly through it, may be half dilated, inactive, eccentric, and somewhat irregular. No red reflex usually can be obtained from the fundus. The sensation of the eyeball when the tension is tested by the clinical method may be almost that of wood. This acute condition is usually found as a primary glaucoma.

The disease must be diagnosed from an acute conjunctivitis or iritis which latter may be very difficult, as iritis may be present and the glaucoma secondary to it. The point is important, because the treatment of glaucoma and iritis is fundamentally different. If the iris can be seen distinctly, the presence of atrophy of the muscle fibres, or newly formed radial arteries, and synechiæ will be in favour of iritis, or of secondary glaucoma. It is to be noticed that examination of the eye for cupping of the optic disc or reduction of the field of vision are all quite useless in acute glaucoma. These are examinations to be carried out in the chronic cases. Some cases of acute glaucoma are in such pain that they are collapsed with a thin rapid pulse and vomit profusely. They may therefore superficially resemble acute abdominal conditions.



AGE 65 GOOD ARTIFICIAL LIGHT. RIGHT EYE. RV= 6/5

CRESCENTIC ENLARGEMENT OF THE BLIND SPOT IN A CASE OF GLAUCOMA

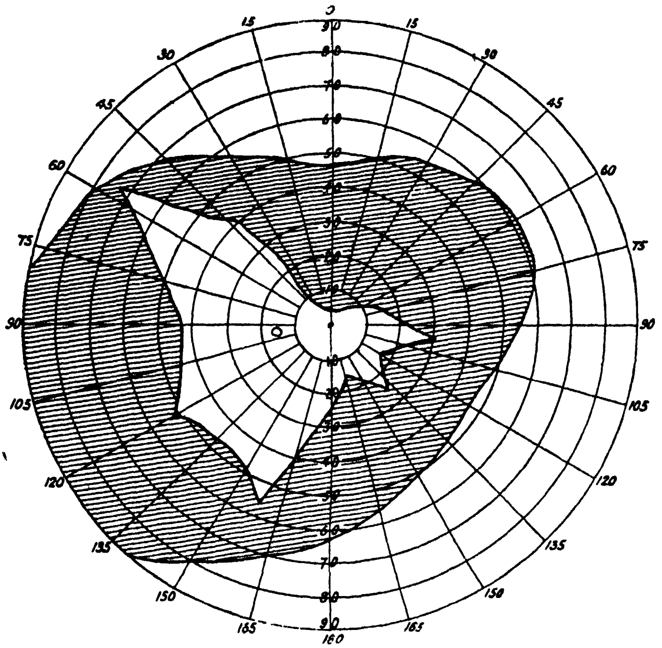
FIG. 93. Chronic glaucoma (*cf.* chart on p. 289).

Chronic glaucoma may be primary, but it is usually secondary to old inflammation within the eyeball. From another point of view, secondary glaucoma is nearly always clinically chronic. The symptoms are of *gradual* and subtle onset in middle age, and consist of:

(*a*) Gradual loss of vision. Such patients, when tested, cannot be improved beyond, perhaps, 6/12ths in spite of careful retinoscopy. They will complain also of a faint mist before the eyes, which comes and goes, and is usually worse in the morning, passing off as the day wears on. They will state further that towards evening, especially after a hard day's work, they see "rings round the lights" like coloured haloes.

(*b*) Gradual loss of the peripheral field of vision, especially to the nasal side, as measured with McHardy's perimeter. This cannot be due entirely to the temporal nerve fibres having the longest intraocular course, and perhaps depends on some peculiarity at their escape from the disc (see p. 287).

(*c*) Gradual enlargement of the blind spot as measured with Bishop Harman's scotometer. The enlargement is crescentic, the horns of the crescent being directed to the temporal side and gradually enveloping the fovea centralis. This crescentic shape marks the course of the nerve fibres from the disc outwards into the periphery of the fundus oculi.



Age 56. 10mm. sq. Good daylight. Left eye. Vision = 6/12ths.

CHART OF PERIPHERAL VISION IN A CASE OF CHRONIC GLAUCOMA.

FIG. 94. Perimetry in glaucoma.

(*d*) Gradual increase of intraocular tension—quite an uncertain sign. The tension rises in a series of waves corresponding with slight attacks of pain and misty vision. The patient may arrive for advice the next day, when the tension has subsided, and the surgeon may see the case over again and never find it raised, his examination corresponding to the depressions between the waves when the tension has subsided.

(*e*) There may be little or no pain.

On examination of the eyeball in chronic glaucoma, cupping of the optic disc is seen, together with (perhaps) signs of old disease of the ciliary body, such as synechiæ, keratitis punctata, and vitreous opacities. The condition may be quite unilateral, but often evidence may be gained from examination of the sound eye, and in every case its function must be carefully tested.

The diagnosis of all glaucoma cases should include a search for a focus of infection (teeth, etc.). Does idiopathic primary acquired glaucoma exist at all ? An attempt always should be made to find the cause. The attacks of increased tension, as mentioned above, may never have been seen actually. A difference between the tensions of the two eyes as measured with a Schiotz tenometer may be suggestive. The discovery of pathological cupping of the disc and abnormalities in the visual field may come as a complete surprise to the surgeon and the patient.

Treatment. In acute cases the symptoms must be treated; in chronic ones the cause must be looked for and eliminated—a general principle of treatment which applies to glaucoma.

General. The patient must be kept in bed and at rest in a darkened room, and a purge given. Some of these cases are very acutely ill and suffer from persistent vomiting. Light diet only should be allowed.

Local. Every attempt must be made to relieve the embarrassed anterior chamber and increase drainage from it. Two or three leeches applied near the outer canthus will relieve the pain in quite a surprising fashion. Hot bathing should be commenced, alternating with dry heat, and ½ per cent. eserine sulphate should be instilled into the conjunctival sac two-hourly until the contraction of the dilated pupil draws the iris away from the angle and relieves the obstruction caused by its presence. Providing the condition has not lasted too long and the treatment is energetically carried out and combined with hot bathing, few cases fail to respond. When the tension has been reduced, it may be thought wise to carry out some operative procedure to save the risk of further loss of vision from a second attack. The alarm caused by the sudden onset of pain and blindness may precipitate glaucoma in the second eye. This should be treated throughout the illness with eserine until recovery is established.

The operative treatment of glaucoma varies as the condition is acute or chronic.

(*a*) For *acute glaucoma* the operation is designed to relieve tension. This can be done under general anæsthesia by paracentesis of the anterior chamber with a keratome. Through the wound thus made an iridectomy can be performed. The lids are retracted with Lawford's speculum, and the eyeball is held with fixation forceps. An incision is made with the keratome or a narrow Graefe's knife in the upper quadrant as peripherally as possible (without wounding the lens or ciliary body) through the corneoscleral junction. Iris forceps are inserted into one corner of the wound, the iris caught, drawn out, and cut through upon one side of the forceps. The iris, still held in the forceps, *is now torn through* (*not cut*) at its peripheral attachment to the ciliary body from one end of the wound to the other, when the portion to be removed is separated by a second cut on the other side of the forceps, the edges of the coloboma being replaced in position by the iris repositor. A considerable arc of the circumference of the anterior chamber is thus freed from the presence of the iris, and, further, the corneoscleral wound, when healed, allows for a certain filtration of aqueous through it. Eyes submitted to this operation often do badly for two reasons: (1) the sudden relief of tension anteriorly results in retinal or choroidal hæmorrhage, with perhaps detachment of the retina; (2) the sodden condition of the iris renders the coloboma liable to become adherent to the edge of the corneal incision, or elsewhere. Further, the anterior chamber in glaucoma being shallow, the lens is liable to be wounded with the point of the keratome.

(*b*) For *chronic glaucoma* the operative procedure is somewhat different. An iridectomy as above will not meet the case, because the formation of a " false angle " prevents the iris from being torn from its true peripheral detachment, with the result that after iridectomy the anterior chamber remains obstructed. The operation that is done is known as trephining.

The lids are held apart with a speculum and the eye directed downwards steadily. Under the local anæsthesia of 4 per cent. cocaine a flap of conjunctiva is cut from above reaching downwards to the upper quadrant of the sclerocorneal junction, the separation being effected with scissors as close to the sclera as possible. Having reached the cornea itself, this is split horizontally with Lawford's sclerotomy knife until the iris just begins to be visible through the cornea. A hole is now made with a sclerocorneal trephine, the instrument being set " astride the limbus," so as to enter the anterior chamber as peripherally as possible. While the hole is being carefully bored with the trephine the flap of conjunctiva must be held vertically under slight tension, so as not to be caught and wounded between the edge of the trephine and the globe. As soon as the hole has been made the trephine is removed ; the circular trephine disc usually lifts upwards as a flap, being still attached at some point on its circumference. This is now cut off. The iris usually presents through the hole as a dark knuckle of tissue ; this is held in iris forceps, drawn a little further out of the wound, and cut off with iris scissors, so as to produce a peripheral iridectomy. The edges of the coloboma are replaced in position with the iris repositor, and the conjunctival flap smoothed back into place, being secured by two or three stitches if necessary. In this way subconjunctival drainage of the aqueous is substituted for that which is no longer possible through the obliterated spaces of Fontana.

RETROBULBAR NEURITIS

Retrobulbar neuritis causes interference with the conductivity of the optic nerve in its path from the eyeball to the chiasma. A condition ensues in which there is marked reduction in the acuity of vision without fundus change. Combined with the reduced acuity the patient complains of pain on moving the eyes. On examination there are found also to be present abnormal pupil reactions and alterations in the field of vision. The condition may be acute or chronic. The causes of the acute form may be local or general.

Local Causes : Injury, inflammation and exhaustion due to overwork or worry.

(1) Injury: Retrobulbar neuritis may occur from hæmorrhage into the orbit or fracture of the base of the skull, if as a result of the injury the optic nerve sheath is torn. If the sheath remains intact neither hæmorrhage into the orbit, nor cellulitis of this cavity, appear to cause retrobulbar neuritis.

(2) Inflammation (*a*) in the surrounding structures, the ethmoid and sphenoid air sinuses has been suggested as a cause of retrobulbar neuritis, but very few actual cases are on record ; (*b*) metastatic infection from the teeth does seem to play a part in ætiology here ; (*c*) retrobulbar neuritis may complicate the course of the acute specific fevers.

A general cause for retrobulbar neuritis is disseminated sclerosis, but here the loss of sphincter control, staccato speech, intention tremor and fleeting paralysis eventually make the diagnosis clear. Attacks of temporary blindness followed, when repeated, by gradually developing optic atrophy are, however, often the first evidence of Disseminated Sclerosis.

In the acute form the disease is frequently unilateral, while when chronic it is bilateral.

Chronic retrobulbar neuritis is usually the result of a toxæmia which may be endogenous or exogenous. Endogenous toxæmias, such as appear in nephritis, diabetes and pregnancy, give rise to it, while of exogenous toxæmias that due to tobacco is most commonly seen. Retrobulbar neuritis also may occur in the course of syphilis or may result from any long-standing infection associated with lowered nutrition and vitality.

Symptoms : (1) Marked loss of vision, more especially for close work, and an inability to see colours ; (2) pain on movement of the globe, which is most marked at the commencement of the acute attack, and hardly complained of in the chronic form.

Signs. (1) The pupil reactions: The pupils react to light directly and consensually, but the reaction is not maintained on the affected side. (2) The fields of vision. (*a*) A scotoma may be present, relative (to colours in tobacco) or absolute. It may be central, paracentral, or sectorial. (*b*) Peripheral reduction of the field may occur, in some cases to the fixation point (Fig. 99).

Examination of the fundus may show different conditions in three stages of the disease: (1) In the early stages the fundus may be normal; (2) in the intermediate stages some diminution in the arteries and increase in size of the veins may be seen; (3) in the last stages "optic atrophy," either total or of the papillo-macular bundle, may appear, because here the ganglion cells as well as their "axis cylinders" are more liable to damage by pathological processes.

In the *differential diagnosis* of Disseminated Sclerosis and Hysteria the above facts are of extreme importance. This disease is apt to occur in young women and war pensioners, where the observer may be biassed. The condition is also often brought on by a "shock." If a doubt remains and an attack of blindness has occurred, examine the pupil reactions and charts of the fields of vision. It is difficult to imagine that the curious findings in retrobulbar neuritis could be simulated by or suggested to the patient. To mistake an early case of Disseminated Sclerosis for Hysteria is serious.

In Disseminated Sclerosis patches of degeneration occur in the optic nerves and tracts. These are not true peripheral nerves, but outgrowths of the brain, so that the rule that the patches do not occur in peripheral nerves is here maintained in spite of the apparent exception.

Treatment. (1) Find the cause: the prognosis depends upon this. (2) Protect the eyes from the light by a pad and bandage or shade. (3) Give rest by the installation of atropine. (4) Provide for elimination by purges and (5) increase resistance by tonics, mercury, iodides and fresh air.

In the chronic type two common causes—tobacco and septic teeth—must both be removed if success is to be obtained. Lack of attention to this sometimes explains the extremely poor results of treatment. In the tobacco cases three conditions may be characteristically associated: (1) Reading is much more affected than distance vision; (2) anæmia is present, due to general tobacco poisoning; (3) indigestion due to the combined effects of the tobacco and the septic teeth is frequently seen. In all cases have the urine examined for sugar and albumen.

STRABISMUS (SQUINT)

Strabismus or squint is a condition due to lack of parallelism of the optical axes. It results from many different causes and is of five main types.

(1) Apparent Squint: where there is an unusual discrepancy between the optical and visual axes, so that although the visual axes are parallel and the patient is obtaining perfectly good binocular vision, the eyes appear to squint. To operate upon such a case is a serious error of judgment. Binocular vision is disturbed, and incurable diplopia (double vision) may result.

(2) Latent Squint: resulting from a defective muscle balance. The defect will be made good by the patient's own efforts provided that his power of binocular vision is good enough to provide the necessary stimulus. In cases where the defect is great, occasional diplopia is present.

(3) Concomitant Squint: associated with high degrees of latent squint in which the power of binocular vision is poorly developed (*e.g.*, in aniso-

metropia); the image seen by the more defective eye tends to be suppressed in consciousness (amblyopia), and hence diplopia is not present.

(4) Paralytic Squint, in which the power of one or more of the muscles is lost and the parallelism of the two eyes disturbed. In this type diplopia is persistently present.

These four types of squint react differently when the patient is asked to look at an object placed at a distance of 6 *metres,* and first one of his eyes is covered and then the other. In a case of apparent squint, the visual axes being both directed at the object, the eyes remain perfectly still. In latent squint the eye which is covered tends to fall away from its position of parallelism because the stimulus of binocular vision is removed. In the majority of cases of concomitant squint, either eye may be made to " fix " the object with equal ease and it is found, by observation of the covered eye, that the angle of squint in each case is the same. In paralytic squint the sound eye can fix the object easily, the affected one with greater difficulty. By observing the covered eye the angle of primary squint, when the sound eye fixes the object, is less than the angle of secondary squint, when the affected eye is made to do so.

(5) One other type of squint is to be seen commonly in patients coming for treatment: a blind eye, from whatever cause, tends to diverge, and as it cannot be made to fix the object the angle of secondary squint cannot be measured.

(1) **Apparent Squint.** Apparent squint is due to a variation between the optical and visual axes which is greater than normal. In apparent squint the visual axes are parallel.

The optical axis, upon which the cornea and lens and sclera are centred, passes through the centre of the pupil and the point about which the eye rotates.

The visual axis passes through the fovea centralis and the optical centre of the refractive mechanism of the eyeball (*i.e.*, the nodal point).

The inner wall of the orbit passes from the orbital opening of the optic canal directly forwards, while the outer wall is directed forwards and outwards. A line drawn from the centre of the orbital opening of the optic canal to the centre of the circle formed by the orbital margins represents the orbital axis, and will also be directed forwards and outwards. When the eyeball is within the orbit its optical axis tends to approximate to this line. For binocular vision the eyes are directed forwards, not forwards and outwards, and hence the optical tends not to correspond to the visual axis, but to make a divergent angle with it. Normally this angle is about 5 degrees, so that, when the visual axes are parallel, the two optical axes diverge from each other at an angle of 10 degrees. We have come to consider this state of things as normal, and when this angle becomes altered say an apparent squint is present.

In hypermetropia the optical axes tend to approximate more closely to the axes of the orbits, and, therefore, are more divergent than usual, and in high degrees of hypermetropia the angle of divergence between the optical axes—the visual axes being parallel—may be great enough to produce an apparent divergent squint. In progressive myopia the optical axes are at first divergent to the normal extent, but as the myopia progresses, stretching of the eyeballs occurs posteriorly to the temporal sides of the discs, causing the optical axes to become gradually parallel and, finally, convergent, when the visual axes are parallel. In high degrees of myopia therefore an apparent convergent squint may be seen.

The angle which the visual makes with the optical axis may be referred to as the "angle γ." When the optical axes are divergent, as in normal eyes and in hypermetropia, the angle is given the + (plus) sign. When the optical axes are convergent the angle is given the — (minus) sign. This is often the case in myopia.

(2) **Latent Squint or Heterophoria.** Latent squint is a condition of defective co-ordination of the muscle balance of the two eyes. Under normal conditions there is no difficulty in maintaining parallelism of the two visual axes for distant objects, or convergence of these axes for close work. When the muscle balance is defective the eyes are kept in their proper position by an increased amount of nervous energy supplied to those muscles which can make good the defect, for if the proper position of the visual axes is not maintained the patient suffers from double vision—diplopia—the bête-noir of binocular vision.

Latent squint can be investigated by placing before an eye a Maddox Rod and directing the eyes at a small bright light. Defects in maintaining parallelism should be investigated with the light at 6 metres distance. For defects in convergence the light should be at reading distance (about 11 inches) away from the eyes. The lamp of an electric ophthalmoscope or torch is convenient for this purpose. The Maddox instrument consists of a rod of glass (or of three or four rods placed parallel to each other) fixed in a lens-holder This is placed before one eye in the trial frame, the other eye being unobstructed. With this piece of apparatus the patient can be given diplopia temporarily, and so the stimulus for his maintaining the proper position of the visual axes can be removed.

With one unobstructed eye he sees the small bright "spot" of light. The Maddox rod before the other converts the light into a "line" of light. He thus sees the "spot" with one eye and the "line" with the other. If the rod is placed horizontally the "line" is vertical and horizontal defects of muscle balance can be measured. If the rod is placed vertically the "line" is horizontal and vertical defects in muscle balance can be investigated.

Horizontal defects—*esophoria* where there is a tendency to convergence, and *exophoria* where there is a tendency to divergence, of the visual axes—can be corrected by prisms placed respectively base out or base in before the eye until the "line" seen with one eye, lies upon the "spot" seen with the other. Vertical defects—*hyperphoria* where one visual axis tends to be raised, and *hypophoria* where one visual axis tends to be lowered, as compared with the other eye—can be investigated by prisms placed respectively base down or base up before the eye until the "line" again lies upon the "spot."

In measuring horizontal defects, which are common, it is sufficient to state that there is so much eso- or exo-phoria. With vertical defects, which are less common, one must state also the eye which is taken as the defective one (*e.g.*, 3 degrees of left hypophoria, which would be identical as to measurement with a similar amount of right hyperphoria). The above description will be more readily understood if the reader will provide himself with a Maddox rod, a prism, and a source of light, and verify the following statements :—

1. A prism displaces the image of an object in the direction towards which its *apex* is pointing.

2. The visual axis is displaced in the opposite direction to the displacement of the "line of light" as seen through the Maddox rod (*e.g.*, if the "line" is displaced downwards "below the spot," the visual axis of that eye is "up,"

and it will be necessary to use a prism apex upwards before it, to make the "line" lie upon "the spot").

Similarly if the "line" is displaced to the left, the visual axis tends to lie to the right, and a prism with apex to the right will be necessary to make the "line" lie upon the "spot."

A similar procedure can be carried out to measure a defect in muscle balance for near work. This is often quite different from the defect as measured for distance, because for near work the eyes are turned downwards, and the inferior rectus and superior oblique muscles have, therefore, a considerably altered power from that when acting in the horizontal position.

Before beginning to measure esophoria and exophoria at reading distance a 5-degree prism should be placed apex down before one eye, and the Maddox rod before the other, to dissociate accommodation from convergence.

(3) **Concomitant Squint.** In apparent and latent squint the visual axes remain parallel under normal conditions and the patient may have perfect binocular vision. In the types of squint which follow the visual axes are not parallel.

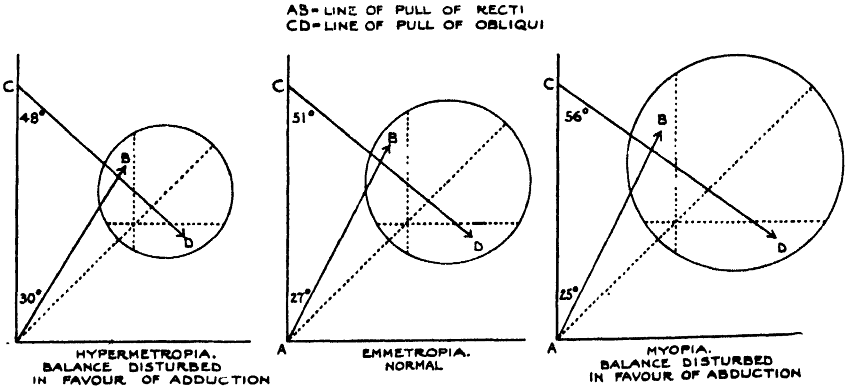


FIG. 95. To illustrate concomitant squint.

Concomitant squint is associated with errors of refraction and connected with binocular vision and heterophoria. A convergent concomitant squint is usually seen in long-sighted eyes. No accommodation is necessary for distant vision in emmetropia, but for viewing near objects the ciliary muscle contracts and the visual axes converge. Accommodation is associated with convergence (and contraction of the pupils) as a synergic act carried out from parts of the third nerve nuclei which are near to each other on each side of the middle line. In hypermetropic eyes, which require for distant vision a constant accommodative effort of the ciliary muscle to correct the hypermetropia, a tendency to the associated convergence is therefore present. Thus convergent squint in hypermetropic eyes is explained, but the liability to divergence of the visual axes sometimes seen in myopia cannot be considered as merely due to a lack of accommodative effort. Into the eyeball as it lies in the orbit are inserted the four recti and the two oblique muscles. These arise from the walls of the orbit in such a way that the oblique muscles make a considerably larger angle (51 degrees) with the inner wall than do the recti muscles (27 degrees). It is that part of the superior oblique which lies between its pulley and the eyeball which directs its force of contraction. The internal, inferior, and superior recti muscles are adductors of the visual axes, and the superior and inferior obliques with the external recti are abductors. In hypermetropia, owing to the diminutive size of the eyeball, the angle of action of the adductors is increased, while that of the abductors is diminished, and hence the balance of power of the groups is disturbed in favour of adduction. In myopia, owing to increase in size of the eyeball, the angle of action of the adductors is diminished and that of the abductors is increased, disturbing the balance of power in favour of the abductors. Reference to the accompanying diagram will help to make this clear (Fig. 95).

Even now a great deal remains to be explained. Many cases of high hypermetropia do not squint, some cases showing convergent squint are myopic, and cases of squint are seen showing scarcely any refractive error at all. Again, some squints are immediately improved by glasses which correct the refractive error present, while the wearing of the proper correction for years has not the least influence upon others.

An investigation of the patient's power of binocular vision explains some of these cases. Treatment should not be undertaken without the co-operation of an orthoptist so that the binocular faculty may be developed to the full so as to obtain a perfect functional result.

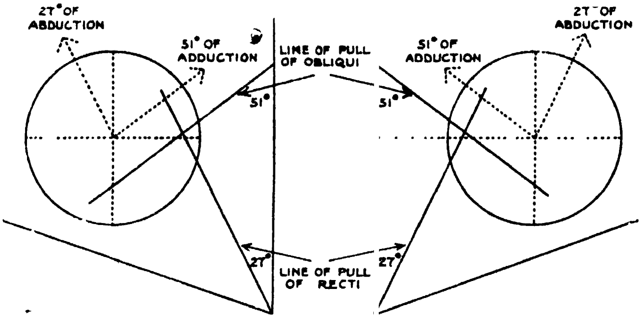
(4) **Paralytic Squint.** The two eyes are normally moved together by the co-ordinated action of the six external muscles attached to each in such a way that the visual axes remain parallel in all positions into which the eyes can be turned. If any of these muscles cease to act parallelism of the visual axes is no longer maintained on looking in certain directions, the movement of one of the eyes being defective. Paralytic squint differs from the forms we have discussed by being accompanied by certain signs and symptoms, of which *diplopia* (double vision) and *false projection* are the chief. The angle of primary squint when the sound eye fixes any object is also less than the angle of secondary squint when it is fixed by the affected eye. In concomitant squint these two angles are equal. Often without obvious strabismus the patient complains when looking at a single object, such as a penholder, of "seeing it double," and that one of the images is fainter than the other and perhaps tilted as well. On following the penholder with his eyes as it is moved in various directions up and down and to the right and left, and keeping his head still, the patient finds that in some directions the distance between the two images is increased, and in others diminished, while a position may be found in which he does not suffer from any double vision at all, and in this position he tends to hold his head so as to overcome his diplopia. The distance between the images is greatest when the eyes are turned in the direction of the defective muscle. If the patient with a paralytic squint is asked to look at the top of a penholder held before his eyes, one eye looks in the required direction, while the other fails to do so, and the angle between the visual axes is appreciable and most easily estimated by noting the positions of the two light reflexes reflected from the corneæ. This angle is called that of primary squint. If the eye which " fixed " the penholder without difficulty is now covered, and the patient is asked to look at the top of the penholder with the other eye, it is found that the angle between the visual axes is now greater owing to the greater effort necessary to make this partially paralysed eye "fix." This angle is called that of secondary squint. The eye which, when it fixes, gives the greater angle of squint is the defective one.

False Projection. The patient should now cover the good eye and look at the top of the penholder with the defective one. While he is doing so the penholder should be moved about and he should be asked to touch the top of it with his finger. It will be found that in some situations his idea of its position in space is faulty, and that he tends to overestimate its position to the left or right, or gives it as too high or too low. The overestimation is greatest in the direction of pull of the defective muscle. As a result of false projection the patient tends to keep his defective eye closed.

Action of Eye Muscles. Before any systematic investigation can be undertaken as to which muscle is actually defective, the normal actions of the various muscles must be appreciated. For this the following table will be useful:—

Nerve III.	Internal rectus.	Adductor.	—	—
Nerve III.	Inferior rectus.	Adductor.	Depressor.	External rotator.
Nerve III.	Superior rectus.	Adductor.	Elevator.	Internal rotator.
Nerve VI.	External rectus.	Abductor.	—	—
Nerve IV.	Superior oblique.	Abductor.	Depressor.	Internal rotator.
Nerve III.	Inferior oblique.	Abductor.	Elevator.	External rotator.

From a consideration of the above table certain facts emerge.



IN 51° OF ADDUCTION OBLIQUI ACT AS PURE ELEVATOR OR DEPRESSOR
IN 27° OF ABDUCTION RECTI ACT AS PURE ELEVATOR OR DEPRESSOR

FIG. 96. To illustrate paralytic squint.

Abduction and Adduction. All of the six muscles have either an abductor or an adductor action. The internal rectus is a pure adductor. The external rectus is a pure abductor. The superior and inferior recti which act with the internal rectus as adductors are less powerful in their assistance than the superior and inferior obliques which act with the external rectus as abductors. To counterbalance this the internal rectus is more powerful as an adductor than is the external rectus as an abductor. The power of the group of adductors is thus balanced by that of the three abductors.

The whole group of adductors is supplied by Nerve III. In all work within a distance of 6 metres some convergence is necessary, so that the two groups of adductors act together for long periods by co-ordinate action of the two third nuclei.

The group of abductors are supplied one from each of Nerves III., IV., and VI. The abductor groups of the two eyes are never in co-ordinate action together, for divergence is never a necessary act.

On turning the two eyes to the right or left the abductors of one eye act with the adductors of the other in a co-ordinate fashion, by means of the third nucleus of one side acting with the third, fourth, and sixth nuclei of the opposite side. Further, the third nucleus of the right side supplying the right internal rectus gives off some fibres which pass by the opposite sixth nerve to the left external rectus, and vice versa.

Elevation and Depression. The inferior rectus and superior oblique muscles also act together as depressors, and the superior rectus and inferior oblique as elevators, the relative amount of power supplied by each component in the performance of the movement varying with the position of the eyes. This will be clearer from the accompanying diagram (Fig. 96). The recti muscles arise from around the orbital opening of the optic canal, and pass forwards to their insertions into the globe, their line of pull, making an angle of about 27 degrees with the inner wall of the orbit. The oblique muscles are inserted into the posterior and outer quadrants of the globe and thence pass forwards to their origins—the inferior obliques to the orbital walls and the superior obliques to their " pulleys "—their line of pull making an angle of about 51 degrees with the walls of the orbit. Hence when the eye is adducted 51 degrees the obliques cease to have any abductor action and become purely elevators or depressors. Similarly, when the eye is abducted 27 degrees, the recti cease to have any abductor action, but become purely depressors or elevators.

These facts are useful if it is desired to discover which, if any, of the elevator-depressor group have become paralysed.

External and Internal Rotation. Wheel-like movement around an antero-posterior axis is normally never seen, because the tendency for one of the elevator-depressor pairs to rotate the eyeball internally is counterbalanced by that of its partner to rotate the globe externally, and vice versa. For the expression of this movement it is convenient to consider external rotation as the movement of a point upon the edge of the cornea corresponding to " twelve o'clock " outwards towards the external canthus. In paralysis of one elevator or depressor the sound partner produces abnormal rotation of the eyeball and tilting of the image seen. It follows that when tilting of the image is present it is due to paralysis of one of the elevator-depressor group, and that the eye with the tilted image is the defective one.

Discovery of the paralysed muscle is effected by consideration of the type of diplopia present, and of the direction in which the eyes must be turned to produce the greatest displacement between the images. The investigation must be conducted systematically, the argument being developed step by step. It is to be remembered that when the images are " crossed " (that is, the image seen with the right eye lies to the left, and that seen with the left eye to the right) the axes are " uncrossed " (that is, the eyes are divergent); whereas when the images are " uncrossed " (that seen with the right eye being to the right of that seen with the left) the axes are "crossed" (that is, the eyes are convergent). Similarly, if the image seen with the right eye is " up," the visual axis of that eye is lowered, and vice versa. Finally, if the image seen with the right eye is internally tilted, then the right eyeball is externally rotated upon its visual axis. *The position of the eyeball and the image it sees are always related to each other in the reverse sense.* There is no criterion as to which eye is the defective one. The visual axes being no longer parallel, which one is at fault remains to be discovered. If the right visual axis is raised this may be due to failure of the right depressors or of the left elevators. The eyes squint relatively to each other and not to any fixed mean.

Take the case of paralytic strabismus into the dark room and put before his eyes a pair of glasses in which there is a red glass before the left and a green before the right (it is useful to keep a standard arrangement, as it facilitates thinking). Let the patient be seated at about 4 feet from a good source of light at which he is asked to look, all the other lights being obscured. For the purposes of the examination it is more convenient to stand close to the patient and move his head up and down, or to the right and left, rather than to move the light. The light is not moved so easily as the patient's head, and by moving his head oneself, one minimises the effect of the mental confusion which is always present in cases of squint. We have now, as far as possible, ideal conditions :—

(*a*) One source of light only.

(*b*) An easy method of distinguishing which image is seen with the right eye, and which with the left.

(*c*) A method of making the patient look quickly in any required direction.

The only thing the patient now has to do is to describe the positions of the images which he sees, and this is often rather more than he can do intelligently. No step is left out of the reasoning in the example which follows.

The patient complains of a diplopia in which one image lies above the other.

Is the diplopia crossed or uncrossed ? The image seen with the right eye (green) lies to the left, and that seen with the left eye (red) to the right.

Therefore, the diplopia is crossed, the visual axes uncrossed and the eyes divergent, the adductors being at fault.

(1) Ignoring for a moment the lateral displacement and investigating the vertical displacement only, the red image (left) is raised, therefore the left visual axis is lowered as compared with the right, due either to failure of the left elevators or the right depressors.

On looking upwards the vertical displacement is reduced, the images approaching one another in this respect, while on looking downwards the vertical displacement is increased. The fault lies with the right depressors, and the muscles at fault are the right inferior rectus or the right superior oblique. When the right eye looks downwards and to the left in 51 degrees of adduction, the superior oblique acts as a pure depressor. In this position the *vertical* displacement of the images is relatively diminished.

When the right eye looks downwards and to the right in 27 degrees of abduction, the inferior rectus acts as a pure depressor. In this position the *vertical* displacement of the images is increased relatively.

When looking down the vertical displacement of images is greatest in abduction when the inferior rectus is chiefly in action. Hence this is the muscle at fault in the right eye. This is confirmed by the previous finding that it was one of the adductors which was at fault, and can be investigated further as follows :—

(2) Considering the lateral displacement only. On looking to the right the lateral displacement diminishes, while on looking to the left it increases. Therefore it is greatest when the adductors of the right eye are in action. Hence, the right adductors are at fault.

(3) The diagnosis of the muscle at fault can be confirmed further by a consideration of the tilt of the image seen with the defective eye, which is as a rule present when one of the elevator-depressor group is involved.

The right (green) *image* is tilted *outwards*, especially on looking to the left.

The rotary effect of the recti disappears in 27 degrees of abduction (Fig. 96), so that weakness of the right inferior rectus (which we believe to be paralysed) would in this position produce no tendency to wheel-like movement of the globe. In 51 degrees of *adduction*, however, the rotatory effect of the recti is at its maximum, and the paralysed inferior rectus would here be unable to oppose the tendency to wheel-like movement of the *globe inwards* produced by its colleague the right superior rectus on looking towards the left.

Ocular torticollis is a somewhat unusual form of squint in which a partial paralysis of the superior rectus of one eye is accompanied by an overaction of the inferior oblique of the other. Suppose the right superior rectus to be defective: On looking to the right the right superior rectus is acting in abduction and the left inferior oblique in adduction. Both muscles in these circumstances have well marked elevator actions (*see* Fig. 96). If the superior rectus is weak it overacts to maintain horizontal movement of the eyeball and the opposite inferior oblique will overact. This results in

(1) *Diplopia* in which the image seen with the left eye is lowered and tilted inwards.

(2) *Head-tilt,* in which the lowered and tilted image seen with the left eye is raised by tilting the head down towards the left shoulder.

(3) Finally *Suppression,* in which diplopia disappears and the head-tilt is abandoned because the overacting inferior oblique no longer causes symptoms.

Occasionally the condition is bilateral. It often yields satisfactorily to orthoptic treatment combined with a free myectomy of the inferior oblique performed through the lower lid.

PERIMETRY

I. **Instruments.** Central or direct vision—by which the *form of objects* is perceived—occurs only at the macular region of the retina. This area, about 1·5 mm. broad, subtends an angle of 4 to 6 degrees outside the eyeball; hence form is seen distinctly in only a very small part of our visual field. In the remaining or peripheral retina *perception of movement* and *orientation in space* take place, which are essential for useful sight. Marked reduction of the peripheral fields of vision results in the patient's being unable to find his way about, especially in low illuminations, even though his central vision may be 6/6 in each eye. This condition is typically seen in case of night blindness.

The fields of vision are normally limited by the shape of the eyebrow and the nose. Their usual extent is upwards 45 degrees, downwards 70 degrees, inwards 60 degrees, outwards 95 degrees, but with specially constructed apparatus it is found that the true visual field is represented by a complete circle subtending an angle of 95 degrees at the fixation point. When looking directly forwards the visual fields of the two eyes overlap by 120 degrees; within this angle binocular vision is possible. It will be noticed that the loss of one eye, besides depriving the patient of the power of binocular vision, entails the loss of 35 degrees of field upon that side. This, though apparently slight, is a serious handicap when working with machinery or moving in crowded thoroughfares. So far the field for white only has been considered. The fields for colours are smaller than for white, and are concentric with it—that for blue being the largest and that for green the smallest, while that for red occupies an intermediate position. In some toxic conditions such as tobacco poisoning, and in cerebral tumour, the field for colour may be lost, while that for white is retained, hence their investigation is sometimes important.

The patient's field of vision may be measured in three ways:

(A) *A rough comparison* of its extent may be made with that of the surgeon. This is most conveniently carried out with *Traquair's Discs.*

(B) *The perimeter* may be used to examine the field more specially for peripheral defects. Two types of perimeter are chiefly in use, namely, McHardy's and Lister's, and in both the measurements are taken on the arc of a circle.

(C) *The Scotometer* may be used to examine the field specially for central defects and for alteration in the size and shape of the blind spot (disc).

Three types of scotometer are in general use: Bjerrum's Screen, Elliot's Scotometer, and Bishop Harman's Scotometer.

In all three measurements are made upon a flat surface.

(A) *Rough Comparison.* To examine the patient's right field of vision the surgeon instructs her to cover her left eye, and sitting facing the surgeon to look at his left eye. By moving Traquair's disc, mounted in its long handle, in the periphery of the field of vision of his left eye (the right being closed), the surgeon may compare the position where he is first conscious of the presence of the disc, with the position at which the patient first notices it. The patient's left eye next may be compared with the surgeon's right in a similar manner. With a little practice considerable information can be obtained from these simple tests. By using the coloured discs the fields for colours also may be rapidly examined.

(B) **McHardy's Perimeter** consists of a graduated arc of a circle made of metal pivoted about a point. Near the centre of the circle of the circumference of which the arc forms part is a movable chin rest, which can be adjusted to bring the patient's eye accurately into the centre of curvature of the arc and keep it there throughout the examination. A white " spot " marked upon the arc at its pivoting point remains stationary in all positions, while another " spot " (the colour and size of which can be altered) is made to move along the circumference of the arc in either direction. This movement is carried out by the surgeon by means of a mechanical device. The instrument includes a hinged holder for a chart, and a pointer which by a system of gearing moves relatively to the spot upon the arc, and renders the recording of results practically automatic. Each field is charted separately, the other eye remaining closed. Two difficulties occur with the apparatus.

1. *The illumination of the moving spot.* If daylight is used the records obtained

upon bright and dull days are not comparable. If artificial light is used its intensity varies with the square of its distance from the object. Apart from this are the difficulties encountered from shadows cast by the patient's head and the parts of the perimeter itself. These shadows can be got over to some extent and the distance of the spot from the light can be equalised by having a system of three lights, one above and one on each side of the patient's head.

2. *The visibility of the traveller,* which carries the spot along the arc's circumference, and *the noise it makes upon its journey.* The patient thus sees " something coming " before he sees the spot, and after repeated examinations knows how far it has travelled by the duration of the sound accompanying its passage.

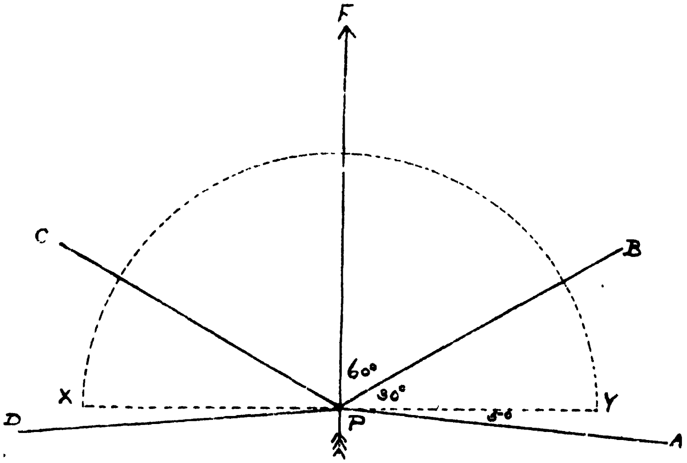


Fig. 97. The angles of vision subtended horizontally by a patient situated at P and looking towards F.

F. = Fixation point.
P.F. = Line of Fixation.
A.P.C. = Angle of Vision, Right Eye = 155°.
D.P.C. = Angle of Vision of which the patient is deprived by the loss of the Left Eye = 35°.
C.P.B. = Angle of Binocular Vision = 120°.
D.P.A. = Total angle of Vision = 95° on each side of F.

Lister's Perimeter. This instrument meets both the difficulties mentioned.

1. The spot is illuminated by a small electric lamp, with a daylight filter, situated at the end of an arc subtending twice the angle of that used in McHardy's perimeter and pivoted at its medial point. Difficulties with the weight of the arc are at the same time overcome and a perfect balance obtained.

2. The traveller is hidden in the body of the arc and travels almost noiselessly in a groove upon ball bearings. The surface of the arc visible to the patient is covered with velvet so that it does not reflect the light, and the colours provided are washable and kept in a box out of the dust and light so that they do not fade or become dirty. The instrument has an adjustment which makes it possible to use it for scotometry, but this is not an essential point.

(C) **Bjerrum's Screen** consists of a square of dull black cloth of 1 metre side fitted upon a roller and stowed like a blind. The patient sits before it at a distance of 1 metre; his head should be supported by a chin and forehead rest, so that his eye remains exactly 1 metre from the screen throughout the examination, and the other eye must be kept closed. The central field is examined by moving Traquair's disc over the surface of the screen, records being made by the insertion of black-headed pins. A " fixation point," at which the patient can look, is provided by a white-headed pin. A " Tangent scale " aids in the transference of the records thus obtained to a chart; or Foster's modification of the instrument will tend to make this easier.

The method is slow, the screen is cumbersome, and the records must be transferred one by one to the chart in the surgeon's spare time. The instrument is, however, extremely accurate. Note that the screen is a flat surface, not an arc of a circle as in the case of the perimeter, so that tangents are recorded and not angles. This does not matter when the angle is small, but the method must not be used in measurements more than 30 degrees outside the fixation point owing to increasing errors introduced at larger angles (Fig. 98).

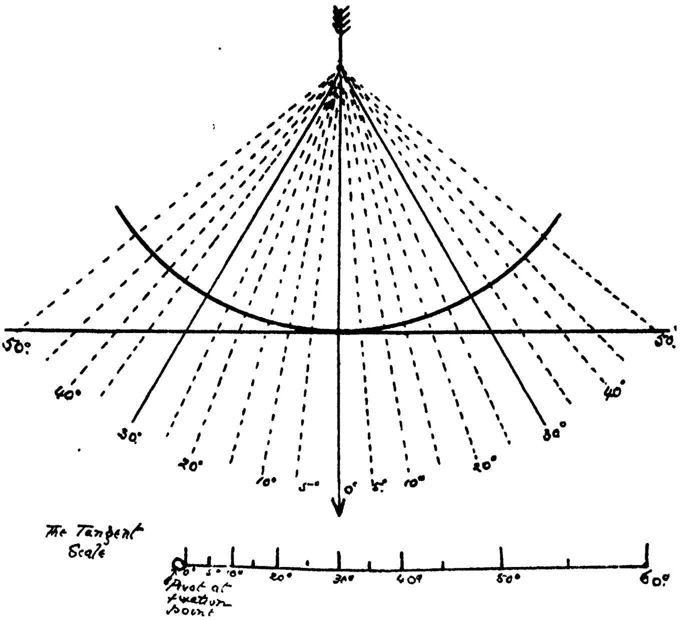


FIG. 98. To illustrate the distortion occurring outside 30° of the fixation point when using the flat Bjerrum's screen instead of the circular arc of the perimeter, and the use of the tangent scale to correct this distortion when transferring the reading to the chart.

Elliot's Scotometer. A circular screen of dull black cloth 1 metre in diameter is pivoted at its centre and able to revolve. Upon this large black disc one of its radii is marked and graduated in black stitching. From the centre of the disc, which is marked with a white " fixation " spot, a white or coloured bead can be moved along a thread which coincides with the radius marked with black stitching. By rotating the black disc as a whole the marked radius can be made to take up any position, and the central field of vision can be thus investigated by the movements of the bead along it. The various readings are recorded upon a chart held in position upon a small desk at the back of the instrument.

The method and apparatus are still cumbersome, but the examination is more rapidly carried out and the recording of results is much easier. The instrument is not so accurate as Bjerrum's screen. A forehead and chin rest is still necessary. A tangent scale is not used. The eye under examination is placed at 1 metre from the screen.

Bishop Harman's Scotometer is built upon the principle of the Perimeter. The distance of the eye from the screen is much less and is automatically fixed by the frame of the instrument. The chart is held in a carrier and separated from the screen in front of it by tracing paper, so that the recording is automatic. The surgeon covers his hand with a black glove and moves spots of different colours mounted upon a handle (like Traquair's discs) about the screen. In this examination the surgeon is sufficiently near the patient to be sure that he is really looking at the fixation point, marked in the centre of the screen by a white bead, and giving his attention to what he is doing. No separate chin and forehead rest is necessary. By using tracing paper of different colours records at different times can be compared on the same chart. The method is easy to use, the examination can be carried out quickly and the apparatus is portable. Some accuracy is sacrificed, but this is to some extent counterbalanced by the surgeon's being able to see that the patient is attending to the examination in progress.

II. Points in the Examination. The fields of vision should be charted in a special perimeter room. The instrument should be placed upon a table, the height of which can be varied, and the patient should be seated comfortably upon an adjustable stool. The test requires concentrated effort, and the patients upon whom it is performed are frequently the subjects of nervous disease; fatigue is thus easily induced and the result completely vitiated. If the consistency of the patient's answers begins to fail, it is better to break off the examination and complete it on another occasion. The surgeon must be careful throughout not to affect the results by "suggestion."

During the investigation the patient covers one eye and directs the attention of the other upon the central fixation spot, which should be about 5 mm. in diameter. He must realise that immediately he sees "something white coming into view" he should give the signal, not waiting until he can distinguish the shape of the moving object, which should be a 5 mm. white square (but may be larger if necessary). The position at which the square is first seen depends upon its (*a*) size, (*b*) illumination, (*c*) *rate of movement.* These three factors, of which the third is usually not appreciated, should be noted upon the perimeter chart together with the names of the patient and the examiner, and the date. The moving square should travel along the arc of the perimeter at a rate of 1 cm. per second, coming into view from without inwards and completing the whole journey to the fixation spot at each trial. A large central blind area thus may be discovered in a visual field of which the outer limits are nôt contracted. Retinitis Pigmentosa—night blindness—shows a paracentral scotoma, the central and peripheral fields remaining normal. Should the patient have a blind central area which prevents his seeing the central fixation spot, he should sit with the tip of his index finger resting upon it, his elbow being supported on the table. He can then direct his gaze to where he knows the tip of his index finger to be, although he cannot see it; thus the peripheral fields can be measured in the presence of marked central defects. To insure accuracy four readings should be taken in each quadrant, and sixteen readings in any quadrant showing a defect so that its shape and size may be accurately represented upon the chart. Whenever a chart of one visual field is made, a chart of the other, made at the same time, should accompany it. Examining the fields for colours sometimes may provide valuable information, as in cases of toxic amblyopia or cerebral tumour.

Investigation of the central parts of the fields should be carried out with special attention to (*a*) defects around the fixation point, (*b*) alteration in the shape and size of the blind spot. Defects in the central area may be present after choroido-retinitis, and alteration in the shape of the blind spot occurs in glaucoma and is known as Bjerrum's scotoma. Throughout the examination the surgeon should see that the patient's eye is directed steadily at the fixation point.

III. Variations in the Visual Fields occur in extraocular and intraocular disease, and records made in the way described above may give valuable information.

(A) *Extraocular.* To understand the changes in the visual fields in *lesions of the central nervous system* we must know the anatomical course of the visual path from the eyeball to the occipital cortex. Below the chiasma the papillomacular bundle occupies, in the first third of the optic nerve, an *external* quadrant of its circumference, but behind this is centrally placed, and therefore protected to some extent from injury. At the chiasma the inner portions of the optic nerves are occupied by the fibres from the nasal halves of the two retinæ, while the outer portions are composed of fibres from the temporal halves. A decussation of the nasal fibres takes place, the temporal fibres do not decussate, but are continued into the optic tracts of the same side. The fibres from the maculæ probably decussate at the chiasma, both maculæ being represented in both optic tracts, but this point remains undecided. The optic tract of each side extends around the crus cerebri and makes communications with the external geniculate body, the superior corpus quadrageminum, and the optic thalamus. From these stations fibres are collected into the posterior part of the posterior limb of the internal capsule, together with those of hearing, and probably of taste and smell. From the internal capsule the optic radiation extends to the internal aspect of the cortex of the occipital lobe. It is divided into a dorsal and ventral division, and passes outwards and backwards in close relation to the descending horn of the lateral ventricle, having this structure behind, internal, and finally in front of it, and the substance of the temporal lobe external to it.

Lesions of the fibres in the visual path, with corresponding changes in the visual fields, occur at four points along their course:—

1. At the optic nerve (below the chiasma).

2. At the chiasma.
3. At the internal capsule (above the chiasma).
4. At the optic radiation.
1. *Below the chiasma* (in the optic nerve) a retrobulbar neuritis results in concentric contraction of one visual field, central, sectorial or paracentral scotoma (for colour especially), or complete blindness in one eye (Fig. 99).

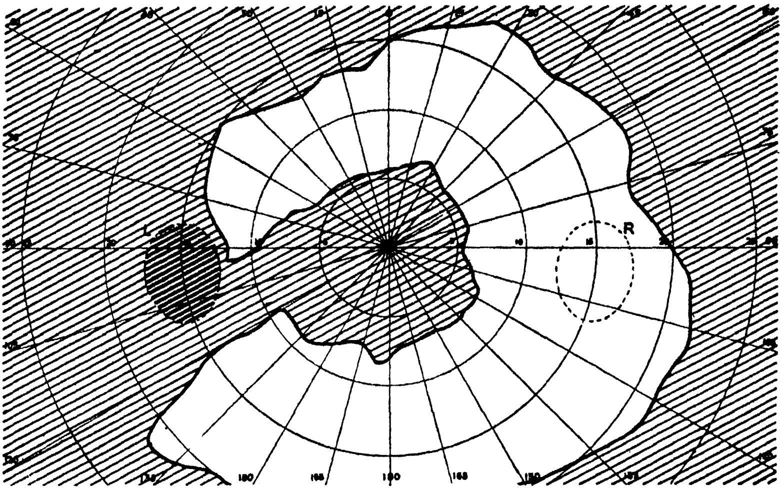


FIG. 99. Chronic retrobulbar neuritis. Male. Age 53. Left vision = ∠6/60. Diabetes. Excessive smoking. Unshaded area shows total field for red. Note (a) Peripheral reduction; (b) Central scotoma; (c) Paresis of papillo-macular bundle.

2. *At the Chiasma.* The pituitary body is in relation to this structure below, separated from it by the diaphragma sellæ, while the stalk of the gland passes upwards behind it. The inner parts of the posterior aspect of the chiasma are occupied by decussating nasal fibres, pressure upon which produces blindness of the nasal halves of both retinæ, and therefore in the two temporal fields of vision (Bitemporal Hemianopia).

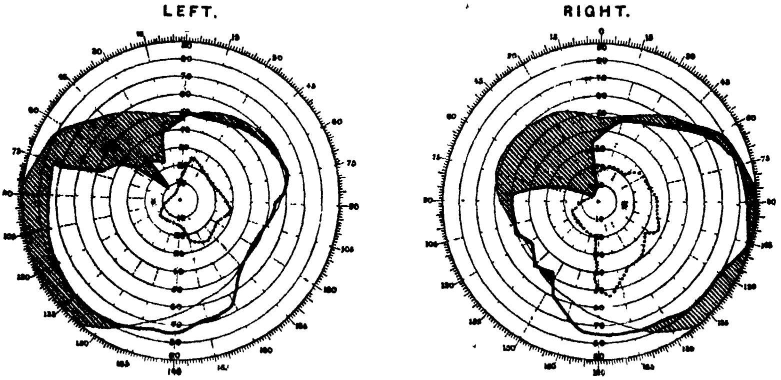


FIG. 100. Dyschromatopsia in a case of Pituitary Tumour. Male. Age 46. 10 mm. sq., good daylight, 1 cm. per sec. Inner dotted outline = field for Blue. *Homonymous* (not Bitemporal) Hemianopia was present. Affection of field for Blue much greater than that for White.

R.V.c̄ + 1·0Ds = 6/6. L.V.c̄ $\frac{+\ 1\cdot5\text{Ds.}}{+\ 0\cdot75\text{Dcy.}}\angle 70^\circ$ = 6/6 pt.

Central vision therefore quite good.

3. *Above the Chiasma* and from here to the internal capsule a lesion of the nerve path will produce destruction of the fibres of the temporal half of the retina of the eye on the same side, and of the fibres of the nasal half of the retina of the eye upon the opposite side (*i.e.*, a lesion of the right optic tract will produce blindness of the right halves of the two retinæ, and loss of the field of vision to the left (Homonymous Hemianopia).

Although bitemporal hemianopia is considered as typical of a lesion of the pituitary gland, it is by no means the only alteration in the visual fields which is found. Put shortly, the position is as follows: (*a*) If the pituitary enlargement spreads upwards and forwards, pressure upon one optic nerve will produce concentric contraction of one visual field. (*b*) If the enlargement spreads upwards, pressure upon the chiasma will produce bitemporal hemianopia. (*c*) If the enlargement extends upwards and backwards a homonymous hemianopia occurs from pressure upon one optic tract. Two points may be noticed: (1) No change in the fields of vision will occur in pituitary disease until the enlargement has left the sella turcica. (2) Whatever change occurs in the fields of vision, the fields for colour will be affected much more markedly than those for white. This symptom—Dyschromatopsia—is characteristic of all cerebral tumours (Fig. 100).

A lesion at the internal capsule gives the same symptoms of homonymous hemianopia as one in the optic tract above the chiasma. Here the hemianopia is accompanied by hemiplegia and hemianæsthesia. In a right hemiplegia the left internal capsule has been damaged. Thus the fibres in the left optic tract and the left halves of both retinæ are paralysed and the visual field is lost to the right (*i.e.*, on the same side as the hemiplegia).

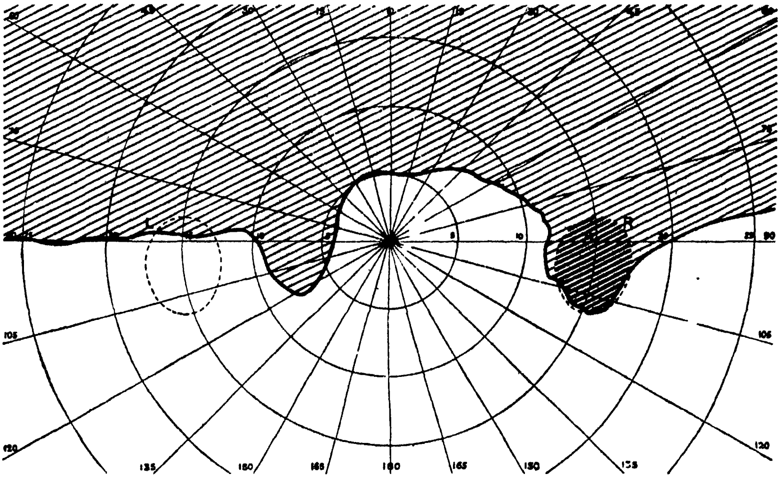


FIG. 101. Right Eye. Chronic Glaucoma. Age 32. Good Artificial Light. RV = 6/12. Peripheral contraction of field fused with concentric enlargement of blind spot (*cf.* chart on p. 272).

It will be found on referring to the discussion upon pupil reactions (see p. 232) that in a lesion of the optic nerve below the chiasma the consensual reflex to light of the pupil of the affected eye is retained while in a lesion above the chiasma light falling on the seeing half of either retina causes contraction of both pupils (Wernicke's reaction).

4. *Lesions of the optic radiation* occur in tumours of the temporal lobe in 40 per cent. of cases. The ventral division of the radiation is usually affected, which results in loss of the *upper quadrants of both visual fields*. The loss in the early stages of the disease (when diagnosis is important) is slight, but more marked in the eye on the side of the disease, especially for colours. Besides the damage to the optic radiation, a curious *visual hallucination*, due to irritation of the temporal cortex, is occasionally seen by the patient and occurs always in the blind portion of the visual field, *i.e.*, in the upper quadrant. This hallucination is organised to a variable extent, and does not consist of flashes of light (typical of tumours of the occipital lobe), but of real

people doing unusual things. Some of the examples which are recorded are that the patient sees:

(*a*) An officer in the uniform of Marlborough's Dragoons.
(*b*) A little black woman cooking.
(*c*) Four men at a card table, one of them throws down his cards and the scene vanishes.

The same scene is enacted time after time, and is only of momentary duration.

The importance of these symptoms is that they enable a diagnosis to be made of the *site* of temporal tumours, a rare thing in cerebral surgery, and without which any attempt at removal is impossible

(B) *In intraocular diseases* the visual fields are altered as a result of:

(*a*) Glaucoma.
(*b*) Detachment of the retina.
(*c*) Choroiditis and retinitis.
(*d*) Vascular disturbances in the retina.
(*e*) Optic atrophy.

(*a*) *In Glaucoma* it is found that (1) the fibres that supply *the temporal half of the retina* are the more liable to injury by the increased intraocular tension. Their longer intraocular course cannot be sufficient to explain this, because the fibres supplying the nasal half seem almost totally immune in some cases. Perhaps the way in which the temporal fibres leave the disc renders them more easily affected by the cupping of this structure. Whatever the explanation, it is a fact that the visual field to the *nasal* side becomes markedly contracted in this disease, the chart showing a "spiky" character (Fig. 94). When the usual smooth contour, which the outer limit of the visual field presents, is lost, the surgeon should always be on the look-out for some pathological process being at work. (2) Besides the peripheral nasal contraction, it is found (on charting the central field with Bishop Harman's scotometer) that the oval shape of the normal blind spot is altered and several variations may be present, *e.g.*, a horn-shaped enlargement above or below may be present (Fig. 93), or a crescentic enlargement, the points of which converge upon and envelop the fixation point. Finally fusion of the crescentic enlargement of the blind spot with the peripheral contraction may be seen in which only the points of the crescent can be made out (Fig. 101). Cupping of the disc is related to the portion of the field which is lost in the following way: If the loss is most marked in the upper nasal quadrant of the field the lower temporal quadrant of the disc will show the edge of the cup approaching most nearly to the edge of the disc. Again, if the crescentic enlargement of the blind spot is most marked in its upper part, then the edge of the cup will coincide most nearly with the edge of the disc in its lower quadrant. Thus the loss of field appears more intimately associated with cupping of the disc than with the length of the intraocular course of the visual fibres.

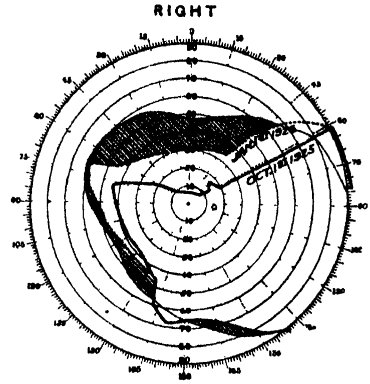


FIG. 102. Case of Detachment of the Retina (lower quadrant). Male. Age 55. Field taken before and after treatment by Cautery Puncture. Vision on each occasion 6/5. Note improvement especially above the fixation point. 5 mm. white square. Good artificial light, 1 cm. per sec.

(*b*) *In detachment of the retina* a chart of the visual field of the affected eye may assist by indicating (1) How near to the fixation point the detachment has extended. (2) What has been gained by treatment. By taking a chart of the field of vision before and after treatment, an ocular demonstration is provided as to how much improvement has been made. (3) How extensive is the lesion in a case of shallow central detachment, occurring near the macula, where its limits are hard to define, because the displacement forwards of the membrane is so slight that even its most elevated portions when examined ophthalmoscopically are in focus (Fig. 102).

(*c*) *In Choroiditis and Retinitis* the patches of diseased retina and the scars that remain provide scotomata, which are more extensive for colours than for white. This is specially true when the patches occur near the macular region. In Retinitis

Pigmentosa a scotoma appears in the area of the field corresponding to that in which the pigmentation appears, namely, the paracentral zone; later the periphery of the field, outside the scotoma, is also lost. The patient in this disease, although his visual acuity remains good, is greatly handicapped by the reduction of the visual field, which finally occurs in both eyes (Fig. 103).

(*d*) *In Vascular Lesions of the Retina.* An artery affected by embolism will give rise to a quadrantic defect in that part of the visual field which corresponds to the area of the retina which it fails to supply with blood. A thrombosed vein will give rise to a similar but much less definite loss. The retina is at first sight much more affected by thrombosis than by embolism, but whereas in the former some recovery is likely to occur, especially if the cause of the thrombosis can be discovered, in embolism of an artery permanent damage is done almost immediately to the part of the retina deprived of blood, and very little, if any, recovery takes place (Fig. 104).

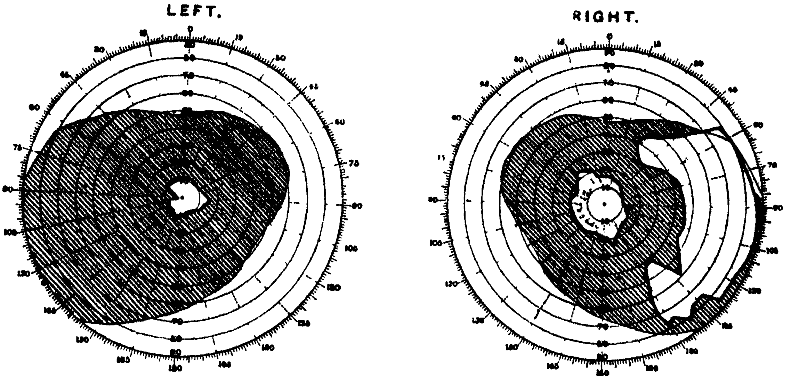


FIG. 103. Case of Retinitis Pigmentosa. Male. Age 45. Increasing Nictalopia since adolescence.

$$\text{R.V.}\bar{c}\ \frac{-\ 3{\cdot}0\text{Ds.}}{-\ 1{\cdot}0\text{Dcy}} \searrow 101^\circ = 6/6. \quad \text{L.V.}\bar{c}\ \frac{-\ 3{\cdot}5\text{Ds.}}{-\ 1{\cdot}0\text{Dcy}} \swarrow 70^\circ = 6/9.$$

Note: Greatly reduced visual fields compatible with good central vision. 5 mm. white square, good artificial light, 1 cm. per sec.

(*e*) *In Optic Atrophy.* This is not a true intraocular cause for loss in the visual field. It is mentioned here to emphasise again two points: (1) A considerable amount of *pallor* of the disc is compatible with fair visual acuity and an almost normal field of vision. (2) A diagnosis of optic *atrophy* must not be made unless also (*a*) the field of vision shows contraction, and (*b*) the visual acuity is reduced.

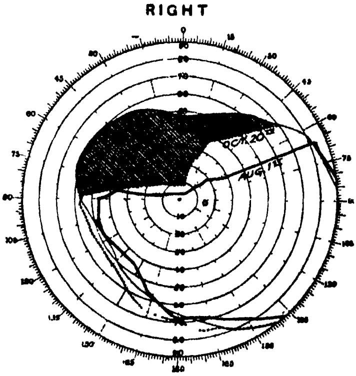


FIG. 104. Case of Embolism of the Lower Temporal Artery of the Retina. Male. Age 58. Field charted (a) just after. (b) 12 weeks after its occurrence. Note very slight improvement especially near the fixation point. 5 mm. sq. white. Good artificial light. 1 cm. per sec. Death two years afterwards from cerebral embolism.

REMOVAL OF THE EYEBALL

Various conditions in the eyeball itself may necessitate this operation.

(1) *Trauma.* An eye so badly injured that there is no prospect of useful vision being regained should be removed at once. If there appears to be a prospect of recovery with useful vision at first, but the eye shows no definite improvement by the fourth day, it should be sacrificed. By these means a long convalescence to no purpose is avoided and the danger of sympathetic inflammation prevented (see p. 246).

(2) *Inflammation of the uveal tract* resulting in an occluded pupil or secondary cyclitic membrane, especially if the eye is soft and shrinking, should be treated by removal of the globe. This condition is seen sometimes in eyes with a retained intraocular foreign body (p. 256).

(3) *Neoplasm.* Intraocular neoplasm calls for immediate removal of the globe, with as long a piece of the optic nerve attached as may be possible.

(4) *Glaucoma.* Eyes having absolute glaucoma and "no p.l." should be removed if they continue to give pain in spite of treatment.

(5) *Sympathetic Inflammation.* An eye which has received a wound in the "danger area" (1 mm. on each side of the limbus) and develops keratitis punctata should be removed. This should be done also if there are signs of sympathetic *irritation* in the opposite eye. If sympathetic *inflammation* has commenced (as shown by the presence of "k.p." and exudate) in the opposite eye, the injured eye should *not* be removed. It may be eventually the better eye of the two.

(6) Lastly, *any blind and painful eye* should be excised.

The operation is carried out as follows: The lids are kept apart with a speculum and the conjunctiva incised around the cornea. By holding the conjunctiva away from the globe in the forceps and cutting outwards beneath it with a pair of blunt-pointed scissors the anterior extremity of Tenon's capsule, which is adherent to the bulbar conjunctiva, is reached and opened. A tenotomy hook can be introduced now into the capsule and the tendons of the six external muscles hooked forwards and cut, the cut being made between the hook and the globe. (Note that the muscles lie outside Tenon's capsule, but their tendons pierce it to be inserted into the globe by specially constructed openings.) The six tendons having been divided, the speculum can be pressed backwards into the orbit, when the globe will be seen "to start from the socket." A pair of fully curved blunt-pointed strong scissors are now inserted behind the globe till the optic nerve can be felt between their blades, when it is divided by one clean cut. Hæmorrhage can be checked easily by irrigation with hot saline and pressure. Finally, the conjunctiva should be sutured with a purse-string stitch. A glass eye can be worn after a period of six weeks.

It should be remembered that an eye suffering from purulent panophthalmitis should be first eviscerated and the sclera removed at a later date when the inflammation has subsided.

Evisceration of the eyeball consists in the evacuation of the disorganised contents, in a panophthalmitis, from within the sclerotic. A wide crucial incision is made through the cornea, and the lens and vitreous removed with the curette.

Exenteration of the Orbit is carried out for the removal of the eyelids and the entire contents of the orbital cavity, and is performed for disorganisation from orbital cellulitis or in cases of advanced sarcoma, carcinoma, or rodent ulcer extensively involving the eyeball and orbital tissues. The knife is inserted just under the supra-orbital margin and swept round, cutting everything close to the bony walls; hæmorrhage is controlled with hot saline and plugging, or the operation may be carried out with the diathermy knife.

WOUNDS OF THE ORBIT

Contusions are not infrequent after blows, and constitute the popular "black-eye" from the colour changes seen in the hæmatoma in the loose areolar tissue. Provided the eyeball is intact no special treatment is called for, save the application of cold compresses to limit the effusion. The lids are more bruised than the subconjunctival tissues in the ordinary black-eye, which may be thus distinguished from blood effusion following fracture of the skull (see pp. 76, 237).

Penetrating Wounds are by no means uncommon, and great care must be used to ascertain that no damage has occurred to the globe or muscles.

Orbital cellulitis is a frequent sequel, and for all these reasons every wound must be explored and cleaned carefully.

ORBITAL CELLULITIS

Cellulitis of the Orbit is a fairly frequent sequel of penetrating wounds, and still more commonly of suppuration in the ethmoidal or frontal air sinuses ; it also may follow infection in the eyeball, lacrimal sac, or eyelids, and facial erysipelas.

Clinically there is swelling, redness and tenderness of the orbital tissues and eyelids, which are brawny and œdematous. The whole eye is prominent (*proptosis*) and movements are limited if Tenon's capsule is involved, while intense chemosis of the conjunctiva is present. Later, fluctuation may be detected.

The condition is of serious prognosis owing to the danger to life from cavernous sinus thrombosis or meningitis supervening, while even if the patient survives, fibrosis in the cellular tissue is likely to cause optic atrophy from pressure or retro-bulbar neuritis if the optic nerve sheath is destroyed.

The eye condition closely resembles that seen in cavernous sinus thrombosis, but in this the œdema is more solid and always to some extent *bilateral*, while the patient is often comatose and very ill.

Treatment consists in incisions around the periphery, so planned as not to damage the orbital contents. This, however, nearly always should be combined with radical treatment of the ethmoidal or other nasal disease, which is usually the cause.

Erysipelas of the lids occurs frequently in conjunction with facial erysipelas.

Tumours and cysts of the eyelids and orbit are discussed in their appropriate chapters.

CHAPTER VII

THE NOSE, NASOPHARYNX AND EAR

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Surgical Anatomy. The two nasal cavities or fossæ are separated from each other by the nasal septum, and each presents for examination a roof, outer wall, floor and two orifices—the anterior and posterior nares.

The Anterior Nares are the anterior orifices of the nasal fossæ, and on inspection through one of them the red nasal mucous membrane can be seen covering the anterior end of the inferior turbinal and mesially a varying amount of the septum. Higher up the anterior end of the middle turbinal usually can be seen.

The Roof is formed by the nasal bones, cribriform plate of the ethmoid and the body of the sphenoid. It is arched from before backwards and the cribriform plate is exceedingly thin, so that an instrument or a foreign body can be driven easily through the dura in this locality.

The Floor is formed by the prenasal processes of the maxillæ and the horizontal plates of the palate bones and inclines slightly downwards and backwards, so that fluid in the nasal fossa tends to gravitate to the posterior nares.

The Nasal Septum is usually deviated more or less to one side and is formed by the triangular septal cartilage, the vomer and the vertical plate of the ethmoid. Inferiorly a bony crest is raised at the junction of the septum with the two palatal processes, which may be so thickened and distorted as to cause obstruction, quite apart from septal deviation.

The Posterior Nares or Posterior Choanæ are two oval orifices about one inch high and half an inch wide. They can be examined by passing a finger behind the soft palate.

The Outer Wall of the nasal fossa is complicated and surgically important. It is formed by the lachrymal bone, the lateral plate of the ethmoid which includes the superior and middle turbinated bones, the superior maxilla, vertical plate of the palate and the internal pterygoid plate.

For the purpose of description, each nasal cavity may be divided into three areas, (1) the vestibule, (2) the atrium, (3) the region of the meati.

1. *The Vestibule* is the area immediately inside the anterior nares; it is lined with skin from which grow a number of stout hairs or vibrissæ.

2. *The Atrium* is a widening of the nasal fossa leading up from the vestibule to the middle meatus and is lined by normal nasal mucous membrane.

3. *The Meati* are four in number.

(a) *The Inferior Meatus*, which lies between the inferior turbinal and the floor of the nose, and into which the nasal duct opens about one-third of the distance back. It is this meatus which can be examined readily by anterior rhinoscopy.

(b) *The Middle Meatus*, which lies between the middle and inferior turbinals. Directly under the middle turbinal is a rounded projection bulging into the nasal fossa and known as the Bulla Ethmoidalis, which is formed by the middle ethmoidal air cells. Anterior to this is the curved uncinate process of the ethmoid, and between these projections runs a gutter-shaped depression, the hiatus semilunaris. The hiatus semilunaris curves upwards and forwards to the infundibulum, into which or near which opens the frontonasal duct. At the posterior end of the hiatus semilunaris is the opening into the antrum of Highmore (the maxillary antrum or sinus). The anterior and middle ethmoidal cells also open into the hiatus semilunaris.

(c) *The Superior Meatus* lies between the superior and middle turbinals, and into it the posterior ethmoidal cells open.

(d) *The Sphenoethmoidal Recess* is situated above the superior turbinal, and the sphenoidal sinus opens into it.

The nasal fossæ (except the vestibule) are lined throughout by the nasal mucous membrane or Schneiderian membrane, with the exception of a small area under the cribriform plate which is covered with the olfactory epithelium.

The *Schneiderian membrane* is ciliated throughout, and is in direct relation to the periosteum covering the bones. It is continuous through the various ostia with the membranes lining the air sinuses. The membrane in the air sinuses, though ciliated, is much thinner and more delicate, and almost may be termed a mucoperiosteum.

Over the inferior turbinal and lower part of the septum the mucous membrane is thicker and full of venous channels, so that it almost amounts to erectile tissue. The mucous and serous gland elements are also increased.

Through the nasal duct the nasal mucous membrane is continuous with that of the lachrymal apparatus.

The Frontal Sinuses, two in number, lie between the two tables of the frontal bone. They vary very considerably in size in different persons, and the thin median bony septum is frequently some distance from the midline, giving rise to inequality in their dimensions in the same individual. An average-sized frontal sinus is 1¼ inches high, 1 inch broad and ¾ inch deep (*i.e.*, backwards from the anterior wall).

They do not exist as cavities till about the sixth or seventh year of life, and fairly frequently one or both are permanently absent. Of the bony wall surrounding the frontal sinus, that of the floor is the thinnest, hence pus retained within the sinus tends to break through into the upper and inner angle of the orbit. The bone of the roof and sides may be irregular, forming galleries and almost separate cavities in the narrow angles between the outer and inner tables of bone.

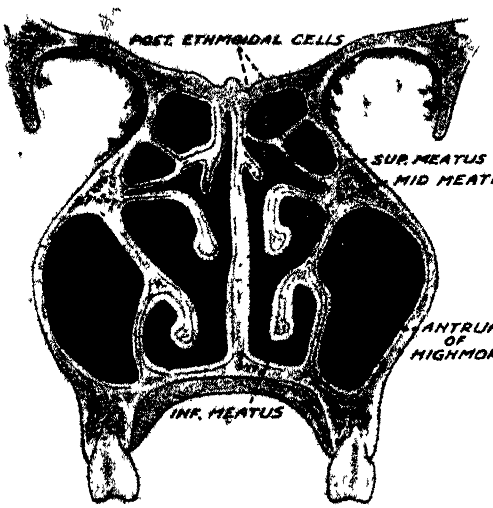

FIG. 105. Coronal section through the nasal fossæ, viewed from the front.

It is not usually possible to introduce even a fine sound into the frontonasal duct without removing the anterior end of the middle turbinal.

The Anterior and Middle Ethmoidal Cells which lie internal to the os planum of the ethmoid (inner wall of the orbit) have their various openings beneath the middle turbinal. The posterior ethmoidal cells open into the superior meatus. The ethmoidal cells vary in number and size, extending from the front right back to the sphenoidal sinus, and although not designated with separate anatomical names, they may be equally important surgically as the larger frontal and maxillary sinuses.

Maxillary Antrum. This is the largest air cell in connection with the nasal fossa and is pyramidal in shape, its base being formed by the outer wall of the nasal fossa and its apex being directed towards the malar bone. The floor of the antrum is below the level of that of the nose, and is only separated from the roots of the bicuspid and molar teeth by a plate of bone of varying thickness.

The antral orifice is situated at the highest part of the antrum, and is therefore unfavourably placed for natural drainage. The maxillary antrum is present at birth.

The Nasopharynx can be explored digitally by placing the finger behind the soft palate It is directly posterior to the choanæ and its roof is formed by the basilar process of the occipital bone articulating with the sphenoid. It is lined with ciliated epithelium.

The orifices of the Eustachian tubes are situated half an inch behind and below the posterior ends of the inferior turbinals.

EXAMINATION OF THE NASAL AIR PASSAGES AND NASOPHARYNX

In order to understand the nature of diseases of the nose it is essential to have a knowledge of the technique of the various methods of examination. Four chief methods are employed :—

1. *Anterior Rhinoscopy, Direct Examination through the Anterior Nares.* The illumination of the cavity of the nose can only be achieved by a projected beam of light. The beam of light should be narrow and bright and the simplest and at the same time adequate means of obtaining this is by the use of an electric lamp attached to the forehead, above the base of the nose, by means of a comfortable fitting head band. Power is obtained from a pocket battery or transformer which can be plugged into an electric circuit.

In a hospital clinic, illumination from a head mirror is probably more satisfactory, as it allows more freedom of movement to the surgeon. An electric lamp of 200 candle-power, with the glass of the bulb frosted, is ideal, the rays being concentrated by means of a lens. The lamp should be placed on the left side of the patient, who is seated in a chair, at about a distance of one foot and slightly behind him. The examiner is seated on a chair opposite the patient and uses a mirror attached to his head, by which the light is reflected on to the patient's mouth and nose. The actual mirror should be about 3–3½ inches in diameter, slightly concave, and should have a hole in the centre of not less than half an inch through which the examiner may see. Having arranged the light and mirror so that the surgeon can see through the centre of the mirror and comfortably examine anything on which the beam of light is thrown, the next step is to open and slightly evert the nostril. This is best accomplished by means of a Thudicum's speculum, which consists of two unfenestrated blades, connected by a U-shaped spring, which is held in the left hand whilst the blades are inserted into the nostril. The blades hold apart the nasal vibrissæ, and the tension of the spring is varied by the hand of the examiner, the limbs of the U-shaped spring being held between the middle and index finger. By this or similar means one is able to see the anterior part of the nasal fossa, the anterior end of the inferior turbinal, a varying amount of the inferior margin of the middle turbinal, and the septum. The distance backwards into the nose which can be seen varies according to whether there is any septal deformity or turgescence of the inferior turbinal. If the mucous membrane on the inferior turbinal is swollen and feels soft on probing, this swelling collapses entirely if a weak solution of cocaine and adrenalin or ephedrine hydrochloride is sprayed or painted over the engorged soft tissue. The dual effect of these drugs is to cause retraction of the mucous membrane and local anæsthesia. It is possible therefore to introduce a longer-bladed speculum if a more thorough view of the upper and back part of the nasal passage is required. A sterilised probe may be employed at this stage and is of the greatest use in determining the character of any swelling which can be seen, and in removing any secretion that may be adherent to the mucous membrane and obstructing the view.

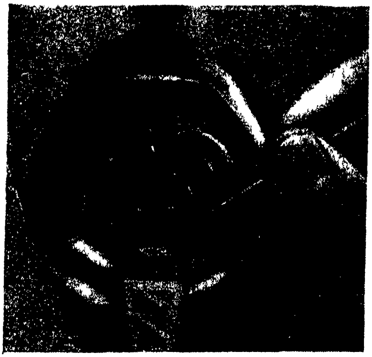

FIG. 106. Posterior rhinoscopy. The mirror shown in the illustration is larger than that generally used.

The various instruments made with an electric bulb attached to the nasal speculum do not project sufficient light into the deeper part of the cavity and are therefore of very little use if a thorough examination is required.

2. *By posterior rhinoscopy* is meant an examination of the posterior nares and nasopharynx with a mirror placed behind the uvula and soft palate. It is by no

means easy to accomplish and requires a considerable amount of practice and dexterity, some cases being much more difficult than others, according to the irritability of the patient's pharynx. It may be necessary to spray the soft palate and fauces with a fine spray of 5 per cent. cocaine solution in order to facilitate the introduction of the mirror. The tongue should be depressed and a small mirror, previously warmed in a spirit lamp to prevent condensation of moisture, is then passed behind the uvula, without touching it or the posterior wall of the pharynx, and by moving it through various angles a view should be obtained of the roof of the nasopharynx, posterior margin of the septum and the posterior ends of the inferior turbinals. The Eustachian orifices also should be seen and any abnormality noted such as the presence of polypi, purulent secretion or adenoids. Owing to the small size of the reflecting surface of the mirror it is essential to have a strong light as a source of illumination. It is a good plan to take the junction of the posterior margin of the septum with the roof of the nasopharynx as a rallying point to view first, it being seen and identified easily.

3. *Palpation of the posterior nares* with the index finger will give better results in the majority of cases to those not specially practised in posterior rhinoscopy, especially in children. The examiner should stand behind the child seated in a chair; the head is fixed with the left hand and the cheek of the child pressed in between the teeth to prevent its closing the mouth. The right index finger is then introduced behind the soft palate and the nasopharynx examined as rapidly as possible. Students should take the opportunity of practising this method of examination on an anæsthetised child, as it is much the most reliable method of diagnosing the presence of enlarged adenoids, and if the surgeon knows what he is feeling for it can be carried through quickly and with no undue disturbance to the patient. Postnasal palpation can be carried out after the administration of a suitable dose of nembutal or similar barbiturate. An hour after this a gag is slipped between the sleeping child's teeth and subsequently nothing is remembered of the examination.

4. Bacterial examination of any discharge which is present may be necessary, and a swab should be taken on the end of a probe introduced anteriorly.

DEFORMITIES OF THE NASAL SEPTUM

The nasal septum should be a flat, thin, vertical plate of cartilage and bone, covered with mucous membrane and dividing the nasal passage in two. Actually it is frequently thickened and deflected from the vertical plane in various ways. A common form of thickening is the so-called **spur,** which consists of a cartilaginous or bony ridge running more or less horizontally in direction. It is congenital in origin. Much the commonest form of spur occurs along the line of attachment of the inferior margin of the septal cartilage to the crest of the superior maxilla, and in this case it is chiefly due to overgrowth of bone, the spur running from before backwards and slightly upwards as a ridge on one, or more rarely both sides of the septum. The ridge, or spur, may be so large as to impinge firmly against the lateral wall of the nasal fossa

A **deflection** or **deviation of the nasal septum** is a bending of the septum from the midline leading to inequality of the nasal fossæ. The cartilaginous part of the septum is usually involved most, and when it is confined to the cartilaginous portion only, the condition is frequently traumatic in origin. The conditions of spur and deviation are usually combined, and when not the result of an injury they are often accompanied by a high arched palate. Septal deformities are more common in individuals who have suffered from adenoid enlargement in childhood, as owing to the obstruction to nasal respiration caused by the adenoids the bones surrounding the nasal fossæ do not develop along normal lines. When there is a marked inequality in the size of the two nasal fossæ it is generally found that the turbinal bones on the more patulous side are hypertrophied in order to fill up the space.

Various pathological conditions may result from nasal obstruction due to thickening of the septum :—

1. "Mouth breathing." This produces retraction of the gums, oral sepsis, dryness of the pharynx during sleep and, as a consequence, loss of sleep.

2. Chronic nasal catarrh.

3. Increased liability to and severity of attacks of asthma, hay fever and to various types of paroxysmal rhinorrhœa or vasomotor rhinitis.

4. Infection of the nasal sinuses owing to the interference with their drainage.

Treatment. If it is decided that the septal obstruction causes a pathological condition of the nose, much the most satisfactory treatment is the operation known as submucous resection of the nasal septum. This operation has displaced all the other septal operations. It may be performed under a local anæsthetic, but general anæsthesia is more commonly used. An incision is made down to the cartilage anteriorly, and by means of special elevators the mucous membrane is separated from the cartilage and bone on both sides, as far back as the posterior margin of the septum. This can be done quite easily and without any bleeding, provided the separation is effected beneath the perichondrium. The cartilage is then cut out, and as much bone as required is also removed. It is important to leave enough of the cartilage and bone superiorly to help support the nose externally, but any bony thickening along the floor of the nasal fossæ may be removed thoroughly. After the operation the nasal fossæ are packed with special plugs, which are left in from 24-48 hours. These act as splints to the septum and prevent the formation of a hæmatoma between the two layers of mucous membrane from between which the cartilage and bone have been removed. The operation of submucous resection of the nasal septum is done most commonly on young adults. It should not be undertaken in children so readily unless the deflection is traumatic or is causing marked obstruction. Operation is then the only method of relief. One advantage of removing the obstruction as early as possible is that once an adult has acquired the habit of breathing through the mouth he is very liable to continue a mouth breather even if the nasal passages are cleared. This applies especially to breathing while sleeping.

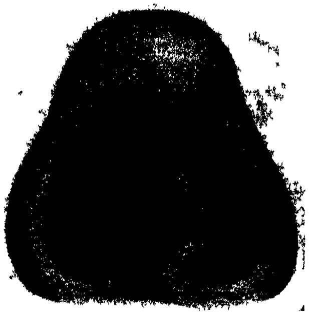

FIG. 107 Deflected nasal septum. The anterior deflection only is shown.

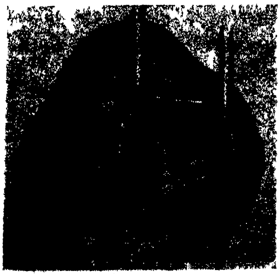

FIG. 108. Submucous resection of the septum. The blades of the speculum have been inserted on either side of the cartilage which has been stripped of muco-periosteum.

Local Anæsthesia in the Nose. The nasal fossæ are first sprayed with a solution of equal parts of a 10 per cent. solution of cocaine hydrochloride and 1 in 1,000 adrenalin hydrochloride. This is introduced into each cavity through a narrow nozzle throwing a fine vapour.

Two or three minutes later, using a nasal speculum and frontal illumination, the nasal mucous membrane is painted over with a similar solution as far backwards and upwards as possible. This is repeated two or three times at short intervals. Instead of the painting the cavities may be packed thoroughly and firmly with ½-inch ribbon gauze, wrung out in the solution, which is left in position for twenty minutes. Alternatively, following the spraying the nasal mucosa is freely painted with a vaseline ointment, containing 25 per cent. of crystals of cocaine hydrochloride and 4 per cent. of the alkaloid of adrenalin.

Surgeons who use local anæsthesia extensively pay particular attention to the mucous membrane adjacent to the spheno-palatine ganglion. This is situated behind the posterior end of the middle turbinal and pledgets of wool fixed on the end of wooden probes may be applied under pressure to this area.

Perforation of the Nasal Septum. This may be the result of trauma, simple ulceration, or a specific disease. When the cartilaginous part of the septum is perforated, it is usually the result of simple ulceration or trauma from a septal operation. Small perforations situated well inside the nose give rise to no symptoms, but if the perforation is near the external orifice irritating crusting of secretion along the edges is liable to occur, causing nasal obstruction and requiring constant nasal douching. In some instances epistaxis is a marked feature, and in others the perforation gives rise to a somewhat unpleasant whistling sound on breathing through the nose.

Syphilitic perforations are almost always in the bony part of the septum. Perforations due to lupus vulgaris are placed anteriorly, *i.e.*, in the cartilage, and there may be marked scarring of the rest of the nasal mucous membrane.

FOREIGN BODY IN THE NOSE

This condition is common in children, due to their introducing buttons, beads, etc. A unilateral nasal discharge and obstruction in a child always should excite a suspicion of the presence of a foreign body. The condition may go on to catarrhal or purulent rhinitis. If the case is of old standing, in the course of years a nasal calculus or rhinolith may develop, owing to the gradual deposit of inspissated mucus on the original foreign body.

The foreign body should be removed under local or general anæsthesia, with frontal illumination and by anterior rhinoscopy. It is essential for the operator to see exactly what he is doing, otherwise damage may be done to the nasal mucous membrane, with resultant adhesions. It is one of the characteristics of the nasal mucous membrane that adhesions readily form between the turbinals and the septum, if by any injury the opposing surfaces become abraded. These then can be removed only by being cut away and the raw surfaces carefully watched to prevent recurrence.

Under no circumstances should any attempt be made to remove a foreign body by forcible syringing. This is dangerous, as is any syringing of the nose at any time, in that it may spread infection into the accessory nasal sinuses or the Eustachian tubes. After removal of the obstruction the nose may be irrigated out with warm alkaline solution until all discharge has ceased.

Injuries of the Nose. Owing to its prominence, injuries to the nose require prompt treatment if only for æsthetic reasons. Cuts and tears of the skin should be stitched up with particular care and the stitches removed as early as possible to avoid scarring. Suturing should be carried out with the finest silkworm gut only and particular care bestowed on the accurate approximation of the cut edges. No dressing need be applied to these suture lines nor indeed need a dressing or covering be applied to any treated facial wound.

Apart from actual destruction of tissue the commonest injuries met with are dislocations of the nasal cartilages and fracture-dislocation of the nasal bones. Displacements of the nose should be reduced *as soon as possible* after the injury, under general anæsthesia. Reduction of dislocated nasal bones may be effected by the use of special flat-bladed forceps, one blade being introduced into each nostril and the displaced bones then raised and moulded into the correct position. Splinting of the nose to prevent recurrence of the displacement is not usually necessary, but if its use is indicated "stent," as used for dental impressions, can be moulded on to suit the case. Plastic operative treatment which may be required for correction of external nasal deformities must be deferred until all signs of inflammation and infection due to the injury have subsided, and this applies to the surgical treatment of any intranasal obstruction which may arise.

The usual final deformities seen are either twisting and thickening of the bridge of the nose or depression of the bony and cartilaginous elements.

Expansion of the nose is most commonly caused by trauma, but it may be due to intranasal disease and obstruction such as nasal polypi, gummata and malignant disease. These are all more common in adults. Adenoids may cause a marked thickening of the bridge of the nose in children, especially if there is any chronic nasal catarrh set up by the adenoids.

INFLAMMATORY CONDITIONS OF THE NOSE

The *skin* of the nose is subject to the affections of the skin over the rest of the face and body (see Vol. I., Ch. IX.). Sebaceous glands on the nose are large and abundant, and acne is quite commonly met with as a result of obstruction of the gland ducts. This chronic inflammation of the sebaceous glands may go on to the condition known as *rhinophyma* or hammer nose (Vol. I., Ch. IX.), but this is now very rarely seen.

Nasal furunculosis is a much more common condition and is characterised by the appearance of an inflamed and painful swelling of some portion of the cutaneous lining of the vestibule.

Inflammation of this kind in the alæ nasi is always localised at its commencement and the pain is usually intense. In spite of the complaints of the patient it is very inadvisable to interfere with the condition other than by applying local heat and cleansing. Incision is liable to be followed by a spread of the infection along the veins of the face to the orbit and ultimately to cavernous sinus thrombosis (see p. 35).

Eczema of the nasal vestibule is sometimes seen, but calls for no special treatment other than that applied to eczema of any part of the skin.

Acute rhinitis, *i.e.*, acute catarrhal inflammation of the mucous membrane of the nose, is characteristically seen in a case of coryza or a "cold in the head."

No specific organism which will cause acute rhinitis has been discovered, but there seems to be no doubt that the condition is both infectious and contagious.

Predisposing causes play an important part in the production of a cold. Bodily fatigue and exhaustion and exposure to violent changes of temperature while in a temporary debilitated condition are frequent predisposing causes. Intranasal causes are deflected septum, the presence of polypi, adenoid vegetations, hypertrophic rhinitis, infected tonsils, etc.

Conditions similar to acute rhinitis may be produced by the administration of certain drugs, or in some people by exposure to dusty or odorous atmosphere. The only pathological change noticeable during any attack of rhinitis is hyperæmia of the nasal mucous membrane and increased secretion.

The symptoms produced are a varying degree of general malaise, headache, stuffiness in the nose and excessive secretion. The secretion is at first watery, but within a few hours becomes mucopurulent. It is not common for there to be any pyrexia. After a few days of mucopurulent discharge from the nose the secretion diminishes in amount and finally ceases, leaving the patient immune to a further attack for a varying but comparatively short period.

Treatment. Prophylactic treatment is important in connection with acute rhinitis.

Any form of "coddling" children, such as keeping them shut up in warm rooms and wearing too thick clothing, renders them more susceptible to "catching a cold."

The habits of taking a cold bath in the morning and regular moderate exercise in the open air are sometimes helpful in making the body resistant to acute nasal infections. Vaccine therapy is frequently very effective as a prophylactic.

There is no specific or really satisfactory method of treating the local congestive symptoms once a nasal infection has become established. Numerous proprietary oils and sprays are worth a trial and they all aim at relieving the congestion and obstruction to the free escape of the secretions from the inflamed mucous membrane.

As briefly as possible the methods of clearing the nasal passages are mentioned below and treatment on these lines is essential and particularly helpful when any of the air sinuses become involved.

Local treatment applied to the nasal cavities to relieve congestion.

The treatments applied locally to the nasal fossæ come into three categories :—

1. Douching and irrigating the cavities with bland alkaline solutions so as to wash away infected and offensive secretions.
2. The application of vapours and fluids which causes temporary shrinking and reduction of fluid engorgement of the nasal mucous membrane. By this means the air capacity is increased, the narrow clefts are opened up and secretion and infection which is retained may be able to escape.
3. The introduction of mild nasal antiseptics or solutions which inhibit or are thought to inhibit the growth of infective organisms.

(1) A convenient alkaline lotion is made by adding about a teaspoonful of a powder containing equal parts of sodium chloride, sodium bicarbonate and sodium biborate to half a pint of warm water.

In an infant or young child this is introduced into each nostril by means of a special nasal irrigator, the child's head being held back. Positive pressure should never be used. Small cotton wool mops can be used to remove the nasal secretion if it is excessive. In an adult the solution can be conveniently introduced from a cup held under the nose, the orifices of the nasal fossæ being immersed below the surface of the solution and the lotion gently sucked into the cavities. As soon as the solution is felt at the back of the throat the cup is removed and the lotion allowed to run out into a basin. Very little practice is required. This irrigation treatment should not be used during the acute stage of a nasal infection, but is useful for removing sticky mucous secretion.

If a patient shows signs of irritation of the Eustachian tube after this treatment it must be discontinued.

(2) An inhalation of steam from a hot solution of menthol—

℞ Menthol . . . . grs. xii
Sp. vini rect. and water . . . . . aa℥i
One teaspoonful to a pint of steaming hot water.

relieves congestion, but it is not of much avail if the nose is so badly blocked up that it is difficult for the patient to inspire air.

An oily solution containing menthol or ephedrine alkaloid, or both, may be instilled into the nostrils by means of a fine glass dropper with the head held back.

A 1 per cent. aqueous solution of ephedrine hydrochloride with or without 3 grains of cocaine hydrochloride to the ounce is also effective.

This instillation should be repeated three or four-hourly. Vaporisers are popular for introducing similar solutions. Adrenalin should not be used as it causes a reactionary congestion which may be severe in certain susceptible people.

(3) Many and various substances and solutions have been recommended for antiseptic purposes in the nose. The nasal mucous membrane being very delicate, only the mildest antiseptics are permissible and they may be introduced by the methods outlined above. A 5 per cent. aqueous solution of argyrol is as good as any.

Purulent Rhinitis. By this term we mean a simple purulent discharge from one or both nostrils as distinct from a mixed discharge of mucus and pus cells.

It is more common in infants and children, and in them should be looked on as an indication for a thorough investigation as to the possibility of congenital syphilis or the presence of adenoids or a foreign body.

Treatment should be directed to finding the definite local condition or specific infection which may be causing the disease, but careful systemic cleansing of the nasal passages should be commenced as soon as possible. Certain specific infections may give rise to acute mucopurulent rhinitis, particularly scarlet fever, diphtheria, measles, smallpox and glanders.

In scarlet fever the nasal inflammation sometimes leads to ulceration and sloughing similar to that which occurs in the fauces and pharynx in this disease.

Diphtheria may be noticed first as a nasal discharge of a mild subacute nature. On examination of the nose a typical membrane is seen, and the diagnosis can be confirmed by microscopical examination of a swab.

Chronic Hypertrophic Rhinitis. By this is meant a chronic inflammatory condition of the nasal mucous membrane accompanied by hyperplasia of the soft tissues and occasionally of the bony structure of the turbinates. The commonest cause of hypertrophic rhinitis is the chronic hyperæmia brought about by repeated attacks of acute rhinitis. This change is particularly liable to occur in people who already have any abnormality in the nose interfering with normal respiration or in those who work in a dusty or irritant atmosphere. Pathologically there is a proliferation of all the elements of the nasal mucous membrane, mucoid, lymphoid, glandular and vascular. The inferior turbinal is more commonly affected, particularly the posterior end of it. The mucous membrane frequently assumes an appearance resembling the surface of a mulberry, and this condition is generally known as "moriform hypertrophy" of the inferior turbinal.

The symptoms complained of are chronic nasal obstruction varying in degree, watery or mucopurulent discharge, constant hawking to clear the postnasal irritation, and attacks of sneezing.

Treatment. In early cases attention to general hygiene and local cleansing may bring about a cure. In more chronic and established cases the application of the electric cautery under local anæsthesia certainly will improve and may cure the condition. The cautery should be used at dull red heat, under direct observation and too much should not be attempted at once. In still more marked cases and in cases where there is definite bony enlargement, partial turbinectomy should be carried out, preferably under general anæsthesia.

Chronic atrophic rhinitis or **ozæna** is a disease characterised by atrophy of the nasal mucous membrane, accompanied by the formation of a crusting discharge possessing a characteristic fœtid odour.

Ozæna occurs in early life and tends to improve spontaneously as the patient gets older. It is much more common in women than men. The exciting cause of the condition is unknown, but different writers have ascribed it to syphilis, chronic purulent rhinitis of childhood, tuberculosis and nasal sinus infection. Pathologically the ciliated epithelium becomes replaced by stratified epithelium, the glands and venous sinuses of the mucosa are degenerated, and the bone is possibly atrophied. The condition may spread backwards into the nasopharynx and pharynx; even the trachea becoming involved.

The symptoms are characteristic. The sickly odour of ozœna which can be detected by the examiner is early present, and this may be so objectionable as to make other people shun the society of the victim. At the same time there is dry crusting and discharge, so marked as to cause partial obstruction to respiration, even though the actual nasal cavity is much enlarged on account of the atrophy of the mucous membrane. Aural complications and tinnitus are frequently present.

The treatment is very unsatisfactory. Regular irrigation of the nose with bland lotion is the first essential in order completely to remove all the crusts. This may be carried out either with a coarse spray or by irrigating each side of the nose from a special glass irrigator.

After the cleansing the nasal cavity may be sprayed with liquid paraffin containing a little menthol, as by this means the mucous membrane is covered with a lubricant which it is incapable of secreting itself.

Nasal lupus is met with usually in patients between the ages of fifteen and thirty. It is more common in females than in males, and it also occurs more frequently than pharyngeal or laryngeal lupus, which are said to be secondary to it. It is often accompanied by lupus of the face. The commonest situation for it in the nose is on the anterior part of the septum and anterior end of the inferior turbinal, where it is seen as small round apple-jelly-like nodules. The condition is not readily diagnosed and is easily overlooked, especially as the symptoms in the early stages are very slight. Pain is absent, but there may be some obstruction and a slight nasal discharge.

Local treatment consists of destruction of the diseased area, either by curettage or by means of the cautery.

Lupus guttata, a form with multiple small vertical streaks on the cheek due to infection from overflow of tears, often occurs concomitantly with nasal lupus, and by many is regarded as indicative that intranasal lupus is present.

Syphilis of the Nose. Apart from the very rare occurrence of primary and secondary manifestations of syphilis in the nose, the tertiary form is met with fairly commonly. The gumma is in all cases the foundation of the various lesions. There may be massive thickening and ulceration, followed by necrosis and destruction of any or all the elements of the nasal fossæ. The commonest intranasal site in which early gumma formation is seen is the septum. The condition has to be diagnosed from lupus, malignant disease, and in the case of the septum from simple ulceration and perforation.

In congenital syphilis the well-known " saddle nose " results from depression of the bridge of the nose, due to maldevelopment of the cartilaginous basisphenoid in this region. A similar condition is seen in achondroplasia (Vol. I., Ch. XVIII.).

ADENOIDS

Pathology. The commonest form of nasal obstruction is that due to hypertrophy of the normal lymphoid tissue of the nasopharynx, also known as

Luschka's tonsil or the nasopharyngeal tonsil. This aggregation of lymphoid tissue is normally present in infants and young children, but should not be of sufficient size to interfere with nasal respiration in any way. Frequent attacks of nasal catarrh or infection with any of the exanthemata tend to increase the hypertrophy of the adenoid tissue.

Adenoids reach their maximum development between the ages of 5 and 15, after which they tend to disappear, and although they may persist into adult life they are not commonly seen after the age of 20.

They are attached to the nasopharyngeal vault extending backwards from the upper posterior edge of the nasal septum almost down to the level of the upper surface of the hard palate, and may be large enough to fill the entire nasopharynx. Laterally they extend into the fossæ of Rosenmüller, sometimes to the posterior margin of the Eustachian orifice. Adenoids are accompanied usually by enlargement of the faucial tonsils.

Symptoms. Owing to the obstruction to nasal respiration, the face may assume a characteristic appearance in a well-marked case. It is lengthened, the mouth is kept partly opened, and the nose is narrowed and may be flattened owing to falling in of the alæ. The inner angles of the eyes are drawn down, the eyelids droop and the whole face presents a stupid and dull look, giving rise to the term "adenoid facies." When asleep the patient keeps the mouth wide open and may snore loudly. In neglected cases there is marked arching of the hard palate and the front teeth become prominent.

When the obstruction is severe, owing to the extra effort required on inspiration and the deficient air entry into the thorax, the bony chest wall becomes narrowed and flattened from side to side. At the same time, owing to deficient oxygenation of the blood, the general nutrition is markedly impaired. Adenoids frequently give rise to Eustachian catarrh, deafness and attacks of earache. This may be followed by acute suppuration in the middle ear and the commencement of chronic aural suppuration.

The adenoids themselves may become chronically infected, giving rise to a postnasal discharge and secondary enlargement of the deep posterior cervical glands, especially in the region of the angle of the mandible. Pharyngeal and laryngeal affections are frequently the result of nasal obstruction due to adenoids.

Among the rarer conditions which may be due to adenoids are asthma, laryngeal spasm, persistent chronic cough, chorea, nose bleeding, nocturnal enuresis, and night terrors.

Diagnosis. The diagnosis of adenoids should be made either by direct observation by posterior rhinoscopy or by digital examination of the nasopharynx (see Nasal Examination, p. 296); in the latter case the growth can be felt, sometimes as a firm mass, sometimes as soft, friable, velvety hypertrophy which bleeds readily. The nasal fossæ must be examined also for the possible presence of any other nasal obstruction.

Treatment. The only treatment for adenoids is their removal by operation, and the common indications for this operation to be performed forthwith are:

1. Nasal obstruction, giving rise to mouth breathing.
2. Chronic nasal catarrh (sometimes associated with nasal sinus infection).
3. Attacks of earache and deafness and chronic ear discharge.
4. Chronic postnasal discharge and persistent cough, with granular pharyngitis.
5. Attacks of asthma and laryngeal spasm.

In infants up to the age of 2½ operative interference should be withheld if possible, but it must be undertaken at once in the event of the obstruction becoming so marked as to cause difficulty in feeding or infection of the middle ear.

The operation always should be carried out under general anæsthesia Ethyl chloride anæsthesia may suffice, but in children ether, and in adults gas followed by ether, is much the most satisfactory anæsthetic, the surgeon then being able to carry out the operation at leisure and under direct observation.

The operation of removal of adenoids is nearly always performed in conjunction with the removal of the faucial tonsils; it is therefore described with the latter operation on p. 342. In the event of adenoidectomy being performed by itself the positioning of the patient and the surgical procedure is in no way altered.

EPISTAXIS

Bleeding from the nose arises from a variety of causes and it is usually unilateral. A common cause is traumatism, and in this case it is simply due to the rupture of a vessel in the nasal mucous membrane. Any variety of ulceration of the nasal septum or turbinals may cause bleeding at any time, and a simple form of this often occurs as an ulcer of the anterior part of the septum from which the scab or crust is constantly " picked," giving rise to hæmorrhage.

Another frequent source of unilateral epistaxis is a small varicose or congested vein on the anterior portion of the septum, just beyond the vestibule. The bleeding vessel can be seen readily by anterior rhinoscopy (vide Treatment), and this form of epistaxis is characterised by always occurring on the same side and being liable to start at any time, but more particularly if the nose is rubbed or " blown." *It is much the most common cause of epistaxis.*

In infants and children epistaxis should always give rise to suspicion of the presence of a foreign body. Young people about the age of puberty frequently suffer from nasal bleeding owing to the vascular disturbances which occur at that age.

In adults, and especially elderly people, spontaneous epistaxis should be a signal to the surgeon to examine the nose as to the possible presence of a new growth, either simple or malignant. Epistaxis commonly occurs as the result of general disease, more especially those associated with high blood pressure, such as chronic renal disease, of which it may be the first sign. Any form of cerebral pressure or congestion may cause it owing to the venous flow from the nose to the cranial sinuses becoming obstructed. A failing heart or chronic pulmonary congestion is another frequent factor. Epistaxis is sometimes severe in cases of typhoid fever. In advanced cases of anæmia nasal bleeding may be so prolonged as to cause death, while in any abnormal state of the blood, such as is present in hæmophilia, purpura and scurvy, epistaxis is usual.

Treatment. In a large percentage of cases of epistaxis the actual bleeding point can be seen by direct rhinoscopy, or a condition may be found to exist in the nose to account for the bleeding. Direct treatment can then be applied at once. As the bleeding is usually in the anterior part of the nasal fossa all that is required is to compress the nares firmly and to apply cold water to the root of the nose with the patient sitting up. The blood is thus given an opportunity of clotting, the circulation reduced and congestion removed as far as possible. In the event of a bleeding point being discovered from a vessel on the septum—and this is found in 70-80 per cent. of cases—the galvano-cautery may be applied at once under local cocaine anæsthesia and the vessel sealed off. The advantage of the cautery over other methods of arresting the bleeding is that the scarring resulting from the healing of the burn usually obliterates the vessel and the condition does not recur. It may be necessary, however, to apply the cautery several times, as too much should not be attempted at once on account of the danger of starting an ulcer of the septum with subsequent perforation. If the epistaxis persists in recurring and any intranasal deformity or obstruction is present causing congestion, it will be found usually that a submucous resection of the septum will prevent it. Failing the use of the galvano-cautery a chromic acid probe should be applied or a small swab soaked in adrenalin. In cases of severe epistaxis it may be necessary to plug the nasal fossa with ribbon gauze soaked in 1 to 1000 adrenalin hydrochloride or weak hydrogen peroxide, and to do this efficiently 5 per cent. or 10 per cent. cocaine should be applied first. If none of the above measures succeed and blood continues to flow back into the nasopharynx, it will be necessary to place a plug in the nasopharynx. To do this a fine rubber catheter or Jaques tube is passed along the nose until the end is seen below the soft palate. The end is then seized with suitable forceps and pulled out through the mouth. A strong silk thread is tied to the tube and the other end of the thread is tied round a pledget of sterilised gauze about 1½ inches by 1 inch in size, or to a small marine sponge previously sterilised. The tube followed by the thread is now pulled out through the anterior nares and the plug pulled into position guided by a finger in the mouth. A second piece of thread should be attached to the plug from the buccal aspect, so that it can be pulled out through the mouth when required, and this should be left hanging out of the mouth and attached to the cheek by adhesive plaster. The postnasal plug will remain in position without any difficulty, but should be removed within twenty-four hours if possible, and the nose gently irrigated with weak, warm alkaline antiseptic lotion. If necessary a fresh plug may then be placed in position.

Epistaxis is sometimes severe and dangerous and in this event the patient should be removed to a place where a suction apparatus is available in order to facilitate the discovery of the bleeding point.

Under these conditions, after the nose has been anæsthetised, a plug may be introduced through the anterior nares in such a way that it can be packed into and occlude the posterior nasal choana.

NASAL POLYPI

Nasal Polypi are the result of chronic inflammation in the nasal fossa and are simply mucous polypi, which on microscopic examination resemble myxomatous tissue. A nasal polypus is inflammatory in origin and is a hypertrophy of the normal mucous membrane lining the nasal fossæ. It consists of a fibrous matrix supporting cells containing mucoid fluid and is freely supplied with blood vessels. The polypus is covered with ciliated epithelium similar to that lining the nasal cavities, but if the polypus presents at the nostril for any length of time, the ciliated epithelium undergoes metaplasia and becomes squamous.

Polypi are usually associated with suppuration in one or more of the sinuses, antra, or air cells connected with the nose. Occasionally, they occur in patients in which there appears to be no evidence of chronic inflammation of the nasal passages, but in such cases they do not usually become numerous or attain large size.

Polypi are usually situated both above and below the middle turbinal, arising from the region of the ethmoidal cells. Frequently they grow from the middle turbinal itself, but are hardly ever found attached to the septum or inferior turbinal. A single large polypus may be present arising from an infected maxillary antrum.

Polypi are generally multiple and often attain a large enough mass to fill up the nasal fossa completely from the nostril to the nasopharynx. The longer a polypus has been present and the more exposed to the air current, the more fibrous and pink-coloured does it become. Old people are more commonly affected than children.

One side only of the nose may show polypoid disease, but more often both sides are involved.

Symptoms. The usual symptoms complained of are nasal obstruction, which may be complete, and the presence of a continuous watery nasal discharge. Any other symptoms which may be caused by nasal obstruction are present in varying degree. There may be, however, no complaint of any kind, and the condition is only accidentally discovered on examination of the nasal passages.

Diagnosis. On rhinoscopic examination the characteristic pearly grey masses are seen, and these may be further distinguished from an enlarged turbinal by the fact that even after the application of cocaine they are soft and freely mobile. An old-standing fibrous and possibly slightly ulcerated polypus has to be distinguished from malignant disease of the nose or from extensive nasal tuberculosis. A small piece may be removed for microscopy, under local anæsthesia.

Treatment. This consists in removal of the polypi either with a snare or forceps, or by curettage of the mucous membrane and cells in the upper part of the nasal fossa.

Removal by the snare is carried out with the patient and surgeon seated in the same position as for rhinoscopy, as in this position any hæmorrhage which may occur can be better prevented from trickling into the pharynx and causing coughing. The nasal fossa is anæsthetised locally and the wire snare is then slipped over the polypus and closed on the pedicle as near to the base as possible.

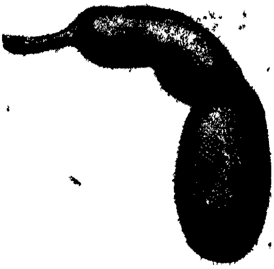

FIG. 109. A large posterior choanal nasal polyp, showing the pedicle and the pendulous extremity which filled the nasopharynx.

As many polypi as can be removed are treated at one time. If hæmorrhage is severe it can be controlled by packing the nose with a sterile gauze plug soaked in adrenalin, as described in the treatment of epistaxis.

The bases of the polypoid growths may be cauterised with the galvano-cautery or silver nitrate probe, and the nose should be examined at intervals to deal with any polypi which may recur, while they are still of small size.

In cases in which there are many polypi and in which extensive infection of the accessory nasal cavities is suspected, or where polypi have recurred after previous treatment by snaring, the best treatment is to administer a general anæsthetic, remove the middle turbinal bone and curette open the infected ethmoidal cells so as to allow free drainage from them into the nose.

Tumours of the Nasal Fossa. All simple tumours of the nose and nasopharynx are *extremely rare*, the **fibroma** being practically the only form encountered. This usually arises in the nasopharynx and is said to spring from the periosteum of the basisphenoid or basioccipital bones. It is commonest in the second decade of life, and in its early stages produces no other symptoms than those caused by obstruction. Severe epistaxis may be the first indication of the presence of a fibroma. The tumour is pink in colour, sessile, and of firm consistency, becoming lobulated later. As it increases in size it causes expansion of the surrounding structures and broadening of the nose as it is probably really fibro-sarcomatous from its commencement. If found early enough it can be removed by some nasal operation such as Rouge's or Nelaton's, or treated with radium.

The only other tumours which have been described in the nasal cavity are papillomata, hæmangiomata, chondromata and osteomata, and they are all very rare.

Osteoma of the nasal cavity is nearly always an extension from the maxillary antrum, frontal sinus, or ethmoidal cells.

Malignant Tumours of the Nose. Squamous epithelioma is said to occur most frequently, but *glandular carcinoma* arising from the ethmoidal region

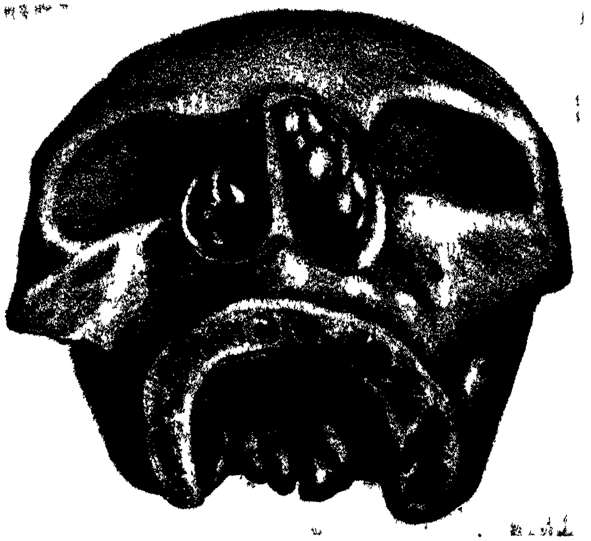

FIG. 110. The anterior part of a skull from which all the soft tissues have been removed except for masses of nasal polypi. The bony palate has also been removed.

is quite common. Carcinomata occur after the age of fifty, and the first symptoms complained of are unilateral nasal obstruction and epistaxis. Later there is pain, and there may be external deformity or swelling. Apart from microscopic examination the tumour can be recognised from simple polypi by its more granular fleshy appearance. The deep cervical glands at the angle of the jaw are eventually involved by extension, but early and thorough removal by open operation may be successful in eradicating a carcinoma arising in the upper part of the nose. Operative measures vary with the extent and site of the disease, but some modification of Moure's operation may be utilised or the exposure for partial excision of the superior maxilla affords a satisfactory approach.

Radium and X-rays are almost always used in the treatment of this type of growth in conjunction with or to a varying extent in place of the operation of excision.

Sarcoma commences in the nose itself quite apart from extension of this form of growth from any of the surrounding tissues. It causes the usual symptoms of obstruction and nasal discharge and may increase rapidly in size. Local removal may be attempted, followed by the application of radium or X-rays.

DISEASES OF THE NASAL SINUSES

The nasal sinuses are merely accessory air cavities connected in all cases with the nasal fossæ and lined with similar ciliated epithelium. Any attack of acute rhinitis may be followed, therefore, by infection of one or more nasal sinuses, especially if the condition is complicated by influenza or one of the specific fevers, and the general resistance of the patient is consequently lower. A congenital malformation of the nose which causes interference with the free drainage of the sinuses renders a patient more liable to an infection of an accessory air cavity.

During an attack of acute rhinitis the mucous membrane lining the air cavities becomes inflamed to a varying extent, but in the normal course of recovery from the infection, and provided drainage is not interfered with, the inflammation settles down without causing any additional symptoms.

For the purpose of surgical description the diseases and infections of the accessory sinuses are separated into Frontal Sinusitis, Ethmoidal Sinusitis and Maxillary Antritis, but all three conditions frequently coexist, and owing to the close proximity of the openings from the various cells and sinuses, infection is very liable to spread from one to another.

In the treatment of acute infection and suppuration in the nasal sinuses, and indeed in the treatment of all severe acute infections of the nose, throat or ear, it may be taken for granted that sulphanilamide should be administered both to prevent extension of the infection and also as a means of checking any severe infection that has become established.

The commonest causative organism is the streptococcus and after that the pneumococcus.

AFFECTIONS OF THE FRONTAL SINUS

The frontal sinuses are two in number, one draining into each nasal fossa. They are not present at birth, and do not usually develop till about the seventh year. They are separated by a thin septum which is irregular in position, frequently being deflected markedly to one side or the other. One or both frontal sinuses may be absent. They vary considerably in size and shape, and the external appearance forms no guide either to the size of the sinus or its shape.

Fractures through the frontal sinus sometimes occur, and the only difference from any other fracture of the vault of the skull is that in this case surgical emphysema may develop by air being forced up from the nose. If it is noted it should be treated by compression, and the patient must refrain from blowing the nose.

Acute Frontal Sinusitis. The frontal sinus is the least frequently infected air cavity of the nose, probably because of its superior position and the fact that in the erect posture the frontonasal duct, through which it drains, is in the most dependent position. The frontonasal duct is narrow and often twisted, and it is, therefore, very easily obstructed by œdema of the mucous membrane. During an attack of acute rhinitis the opening of the duct may become occluded temporarily by the swollen mucous membrane in the nose, with the result that secretion within the slightly inflamed frontal sinus is unable to escape and the symptoms of catarrhal sinusitis are produced. If the congestion is not relieved the condition may pass to acute suppurative sinusitis, and the frontal sinus becomes filled with pus. If the obstruction to drainage is still unrelieved or only partially relieved the infection may spread through the floor of the sinus into the orbit or backwards into the meninges and brain. In addition, there is a danger of an acute osteitis of the frontal bone developing (see p. 84).

Symptoms and Diagnosis. Pain and tenderness over the affected sinus are the commonest early symptoms. The pain is at times very acute and is accompanied by headache. Nothing can be seen by examination of the nose except congestion of the mucous membrane round the anterior end of the middle turbinal. If the condition goes on to suppuration the pain probably becomes more severe, but the length of time of the transformation from catarrhal inflammation to suppurative may be anything from six hours to several days. Streaks of pus are seen at this stage beneath the anterior end of the middle turbinal coming from the region of the frontonasal duct. At the same time there may be slight œdema and redness over the frontal sinus externally. If the condition is unrelieved and the bone of the roof of the orbit becomes eroded there will be marked œdema of the upper eyelid and eventually a fluctuating palpebral swelling. Simultaneously owing to relief of the tension within the sinus, there will be a partial relief from pain. Malaise is usually well marked, as also is pyrexia. In the event of the infection spreading to the meninges, the symptoms of meningeal and cerebral irritation in their usual forms will be present. If there is a spreading infection or osteitis of the frontal bone the symptoms will be even more acute, and there will be marked inflammatory œdema spreading upwards and backwards over the frontal bone, high temperature and delirium (see p. 84).

When pus is present in the frontal sinus it will cause marked opacity of the affected sinus in an X-ray film.

Treatment. In the early stage treatment should aim at relieving the congestion round the frontonasal duct by the methods already described (see Acute Rhinitis). Aspirin, or even morphia, should be given to relieve the pain, and a sharp purgative must be administered. Under this treatment the symptoms will usually subside.

In the event of suppuration occurring in the frontal sinus it is sometimes necessary to administer an anæsthetic, remove the anterior end of the middle turbinal, and dilate the duct with special sounds. But if the case is first seen during the suppurative stage, similar remedies to those described above for acute catarrhal infection should still be tried.

If there is no improvement in the condition following intranasal treatment, the case must be treated by opening the frontal sinus externally. Several operations are described for this purpose, but the object aimed at in all should be to re-establish drainage from the frontal sinus into the nose. A curved incision is made below the eyebrow and extending down in front of the inner canthus to the level of the bony floor of the orbit. The periosteum is stripped back from the frontal bone and inner wall of the orbit, the sinus thoroughly opened inferiorly, and the ethmoid bone and cells round the frontonasal duct removed freely to allow drainage. A large-sized rubber tube should be left in for at least a week running from the nose to the frontal sinus, but the external wound may be stitched up. In a case of acute osteitis of the frontal bone large flaps should be turned back and the anterior wall of the sinus and outer table of the frontal bone freely removed until healthy diploë is found (see p. 84).

Chronic Infection of the Frontal Sinus. This is usually a sequel to an acute infection or may spread as a chronic infection from the anterior ethmoidal cells. Pus is present beneath the middle turbinal on the affected side and a unilateral nasal discharge may be complained of. There is usually varying tenderness over the sinus on external pressure, and frontal headache is complained of, which is worse on rising in the morning owing to the fact that drainage is less efficient in the recumbent position. X-ray examination is very helpful in the diagnosis of these cases.

Treatment should be intranasal and on similar lines to that of acute sinusitis. The anterior end of the middle turbinal must be removed and sounds passed to dilate the duct. The sinus may be washed out with a special cannula, but this form of treatment is not likely to be successful unless free drainage is established at the same time. If the condition is resistant to careful intranasal treatment, an external operation, similar to that advocated for the treatment of acute sinusitis, must be performed and the sinus laid freely open into the nose by removing all the anterior ethmoidal cells.

Occasionally cases are seen in which the frontonasal duct is completely occluded and the frontal sinus becomes filled with a thick glairy fluid which is sterile on culture. The walls of the sinus become expanded and eroded and a fluctuating swelling may form above the eye. If left untreated the eye is gradually pushed outwards and downwards. This condition is the so-called **mucocele of the frontal sinus** and its exact pathology is not known, but it is believed to be due to abnormal growth of one of the mucous glands in the membrane lining the sinus.

Tumours of the frontal sinus are rare. Osteomata are occasionally seen and the frontal sinus may be involved in sarcoma, or carcinoma extending up from the ethmoidal cells.

AFFECTIONS OF THE MAXILLARY ANTRUM

The maxillary antrum is present at birth, though only of very small dimensions. It rarely requires surgical treatment before the age of puberty. It is lined throughout by ciliated epithelium, similar to that lining the nose, and the mucous membrane of the antrum is continuous with that of the nose through the opening connecting the antrum with the nasal fossa. This opening lies in the hiatus semilunaris beneath the middle turbinal. It thus will be seen that the only opening allowing normal drainage of the antrum is situated high up on its inner wall.

Acute Infection of the Maxillary Antrum. The most common affection of the antrum is infection going on to suppuration, and this cavity requires separate treatment more frequently than any of the other nasal air sinuses. Infection may spread from a septic tooth root, and often starts as a result of a tooth extraction, but more commonly it arises as an extension from the nasal fossa. In all cases of acute coryza the antra are bound to be more or less inflamed, but this condition ordinarily subsides with the resolution of the infection of the Schneiderian membrane, and in any case the antral inflammation is much less intense. In certain cases, however, the maxillary antrum becomes filled with mucopurulent secretion, drainage through the natural ostium becomes blocked, the retained secretion becomes purulent, and the symptoms of acute maxillary antritis become manifest.

Symptoms. The most constant is a feeling of congestion with a varying degree of pain on the affected side, quite definitely referred by the patient to the region of the antrum. The nasal congestion and secretion are usually more pronounced on the same side, and pain and tenderness are often present when the teeth in relation to the antrum are pressed. The pain is sometimes very severe, and swelling of the cheek is often quite noticeable. In a severe attack there is marked febrile disturbance.

Diagnosis is established by the history of an acute coryza, and by the presence of the typical symptoms. It should be borne in mind that acute maxillary suppuration is often only established and requiring treatment at a time when the actual nasal infection has almost resolved.

Transillumination by means of an electric lamp placed in the mouth is of valuable assistance. If both sides appear clear the presence of pus in the antrum can be excluded, but if one side only is dark, it is highly suggestive of disease on the darkened side. Frequently both antra appear dark, and unless there are symptoms of inflammation on both sides transillumination is not of much help in such a case.

A radiograph of the antra is of still more value; the infected side is more opaque to the rays. An alveolar abscess extending upwards under the periosteum on the front of the superior maxilla may simulate an infected antrum. It gives rise to a similar train of symptoms, and causes dulness on the affected side on transillumination, but if the upper lip is everted a fluctuating swelling can be detected readily if an alveolar abscess is present.

Treatment. This depends to a certain extent on the severity of the symptoms and their duration. Where the pain is not severe or amounting to a dull ache, which has been present for twenty-four hours only, it often will be found that the condition will subside if treatment is instituted on the lines recommended for acute rhinitis and frontal sinusitis. If the congestion persists for a day or two, or if the pain is at all severe, as it often is, great relief to the patient can be given by evacuating the pus from the antrum.

Aspiration of the pus can be carried out under local anæsthesia with a small trocar, and this will probably require to be done several times. The antrum can be drained even more effectively by cutting out a still larger opening beneath the inferior turbinal by means of a specially designed instrument, but this will require more thorough local anæsthesia and even may necessitate the use of gas and oxygen inhalation as an adjunct. In the event of persistence of the symptoms of pain, pyrexia and purulent discharge the operation of intranasal antrotomy should be performed (p. 316).

Chronic Infection of the Maxillary Antrum. This condition most commonly arises from neglect or failure to diagnose and treat an acutely infected antrum. Following an acute infection the symptoms pass off after a varying length of time, but the pus may persist in the cavity, and only be detected by a careful examination. An infected root of a tooth sometimes causes a chronic antral suppuration without any acute stage being noticed. Another not unusual source of infection is the frontal sinus, the pus running down from the frontonasal duct along the hiatus semilunaris and flowing into the antrum.

Symptoms. As has just been said these are often very indefinite, and may be completely absent for months, while all the time the antrum is filled with stinking pus. On the whole the symptoms are very similar to those evinced by an acute infection, but are much less severe. Owing to the fact that the nasal fossæ themselves are not inflamed during a chronic maxillary antritis a unilateral nasal discharge is often present in association with this disease. It is caused by an overflow of the pus through the partially closed naso-antral opening. This may cease for a time owing to the obstruction becoming complete, and then recommence after an attack of pain which is caused by the rise in tension of the retained fluid. Cacosmia is often present. Severe infraorbital neuralgia may be the only symptom of antral suppuration.

Diagnosis. The history of the case together with examination of the nasal fossæ for pus, transillumination of the antrum and radiography, will settle the question more or less, but where possible an examination of the contents of the antrum by aspiration always should be carried out. The latter can be done under local anæsthesia, by passing a specially shaped trocar and cannula beneath the inferior turbinal into the cavity.

Treatment. The cure of chronic suppuration within the maxillary antrum only can be effected by re-establishing adequate drainage from the cavity. The normal drainage from the antrum is by the natural opening situated beneath the middle turbinal; it is therefore reasonable by means of surgical treatment to drain away the pus into the nose. The operation of intranasal antrotomy (p. 316) provides adequately for antral drainage in that it opens the cavity as low down as possible, thus facilitating the escape of the fluid. In very chronic cases, some modification of the Caldwell-Luc operation may be required (p. 316). This is because the lining membrane of a maxillary sinus, or any other nasal sinus for that matter, which is the seat of chronic infection, becomes thickened and polypoid, and a cure can only be effected if this thickened and diseased membrane is removed.

The Caldwell Luc approach makes this removal of membrane possible.

Polypus of the Maxillary Antrum. This condition, although similar in its pathology to that which produces the nasal polypi already described, deserves special mention because of the fact that it produces a single large polypus which may fill the nasopharynx entirely and which is connected by its pedicle, through the maxillary ostium, with the mucous membrane lining the infected antrum. Although the polyp can be seen easily on posterior rhinoscopy or felt on palpation of the nasopharynx it may be invisible by anterior rhinoscopy.

Nasal polypi arising from the ethmoidal cells, and these are much the commoner variety, never extend into the nasopharynx.

Treatment is by means of some radical operation which will improve antral drainage and enable the base of the polyp to be dealt with. (See p. 316.)

Tumours of the Antrum. Fibromata, odontomata, sarcomata and carcinomata are found at times. Varieties of osteomata are also occasionally met with. These may be soft cancellous osteomata associated with chronic infection of the accessory sinuses and resembling, pathologically, the bony overgrowths met with in the condition described as leontiasis ossium (Ch. XVIII., Vol. I.). If not too far advanced the growth may be removed by a buccal operation or by a modification of the operation for removal of the superior maxilla.

The maxillary antrum may become filled with fluid and expanded, due either to a dental cyst completely filling the antral cavity or to a cystic tumour forming from one of the glands of the mucous membrane lining the antrum. In such a case the buccal wall or anterior wall of the antrum is most commonly expanded and thinned. Eggshell crackling or even fluctuation may be elicited. The condition has to be differentiated from new growth and is treated by opening the cyst from the mouth and, if possible, removing its wall intact. Chronic suppuration never causes this diffuse expansion of the cavity.

AFFECTIONS OF THE ETHMOIDAL CELLS

The ethmoidal cells lie along the inner wall of the orbit, the anterior and middle group of cells opening beneath the middle turbinal bone and the posterior group above and behind the middle turbinal.

Ethmoiditis. The ethmoidal cells may be the seat of acute or chronic suppuration. If the attack is acute, pain is complained of between the eyes, with headache, and there is a free purulent nasal discharge, the patient complaining of all the symptoms of a severe cold with intense central headache, and pyrexia. Sometimes the drainage of the cells infected is obstructed and the nasal discharge is absent. In either case there is danger of the infection breaking through into the orbit and causing orbital cellulitis, or the infection may spread upwards, giving rise to meningitis. In all cases of orbital suppuration the ethmoidal cells should be suspected. Chronic suppuration of the ethmoidal cells is one of the causes of nasal polypi, and it also may cause destruction of the mucous membrane and necrosis of the bone. In the latter event the patient will complain of cacosmia, constant nasal discharge and objectionable crusting in the nose. X-ray examination is helpful in diagnosing suppuration in the ethmoidal cells.

Treatment. The essential element in the treatment is to secure drainage of the affected cells. This may be obtained, especially in the early acute cases, by means of free nasal douching and the application of sprays to reduce the congestion. During the acute and pyrexial stage of acute infective ethmoiditis operative interference is contraindicated but later on a cure may be expedited by removal of the middle turbinals and any polypi which may be found obstructing the nasal cavity. In the more serious cases and those which resist less radical treatment it will be necessary not only to remove the middle turbinal, but also to open the ethmoidal cells themselves freely into the nasal cavity. This can be done by an intranasal operation, and if carried out thoroughly the ethmoidal cells can be completely curetted away down to the os planum of the inner wall of the orbit. If the operation cannot be carried out intranasally it may be done through an incision made vertically about one-third of an inch in front of the inner canthus. The incision should be less than one inch long, and is made straight down to the bone, the periosteum is separated from the whole of the inner wall of the orbit, and the os planum and all the ethmoidal cells are removed.

The sphenoidal sinus may be infected alone, but more usually there is infection of the ethmoidal cells as well. There are two sphenoidal sinuses, a right and left; they are very irregular in their size relative to one another, and their opening into the nose is towards the upper and anterior part of the anteroinferior wall of the sinus. Their drainage, therefore, is not satisfactory if they become infected, but it can be improved readily by punching away the lower wall of the sinus by means of specially devised forceps. Owing to the close proximity of the optic nerve to the sphenoidal sinus, infection of the sinus sometimes causes retrobulbar neuritis.

Various orbital and optic inflammatory conditions may be secondary to infection of the ethmoidal and sphenoidal sinuses, and these cavities should be always under suspicion in such cases.

INTRANASAL OPERATIONS

When considering operations on the nasal fossæ it must be remembered that if the Schneiderian membrane is destroyed by disease or trauma it does not completely regenerate, but is partially replaced by scar tissue. The function of the nasal mucous membrane is to moisten the inspired air, warm it and filter it, and for this reason it is of great importance not only to preserve the membrane healthy, but to damage it as little as possible in the event of operative interference.

Operations. A very large number of differently named operations have been devised for the treatment of diseases of the nose and nasopharynx, but it is only necessary to mention here a few of the most useful, and especially those which form the basis from which various modifications have been developed.

All the minor surgery of the nose and nasopharynx may be performed without an external or buccal incision of any kind. This includes septal operations, removal of portions of the turbinated bones, removal of polypi and intranasal drainage of the accessory air sinuses. It is essential in all intranasal operations to have that portion of the nasal cavity which is being dealt with under direct view and at the same time satisfactorily illuminated. The illumination is best secured by means of a headlight which projects a bright beam of light from between the operator's eyes into the cavity, and in order to produce a good contrast it is as well to have the operating room darkened. The nostrils are dilated by means of a Thudicum's speculum or by various sizes of Killian's speculum. By means of the latter forcible dilatation of the nares is obtained. The nasopharynx is approached by gagging the mouth well open, pulling the tongue well forward and raising the soft palate gently by means of suitable retractors. In dealing with polypi or growths in the nasopharynx it may be necessary to rely partly on digital exploration.

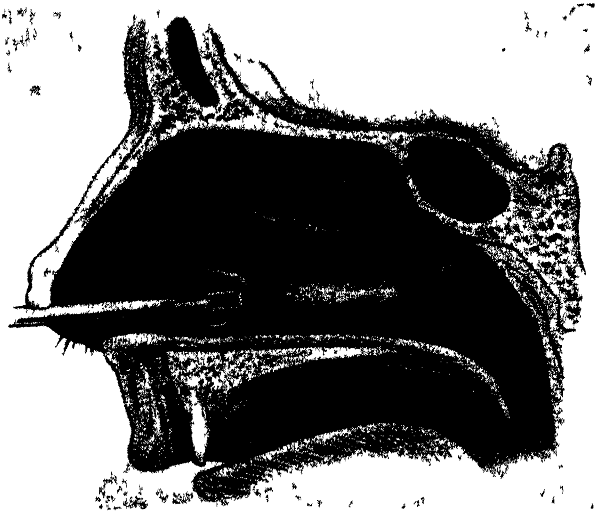

FIG. 111. Intranasal antrotomy.

Many intranasal operations can be carried out under local anæsthesia (see p. 298). In this country it is more usual to make use of general anæsthesia for nasal operations, and in all cases the first step in the operation should be the insertion of a suitable postnasal plug (sponge) in order to prevent the blood from flowing down into the pharynx. During the operation the anæsthetic is continued by means of a metal tube passing the vapour directly through the patient's mouth.

Even in the event of a general anæsthetic being employed the nasal fossæ should be plugged half an hour before operation, with gauze wrung out in a solution of equal parts of 5 per cent cocaine and 1 in 1000 adrenalin hydrochloride, as by this means the hæmorrhage will be much reduced.

A suction tube (*i.e.*, continuous suction) will be found of use in all nasal operations. It will remove any blood which is obscuring the view in the affected cavity and is indeed of value in all operations on the upper respiratory tract.

(1) **Partial or complete turbinectomy** is carried out by cutting through the turbinal from before backwards by means of special angled nasal scissors, the free or partially freed bone being removed by Luc's forceps.

(2) **Intranasal maxillary antrotomy** consists in removing a small anterior portion of the inferior turbinal and then plunging a special large trocar into the antrum through the thin bony wall beneath the turbinal. The opening is then enlarged backwards and forwards by means of special forceps, and the broken bone and mucous membrane are carefully removed. It is important to make the opening large and with clean cut edges, as there is a marked tendency for it to close up.

(3) In the **Caldwell-Luc operation** or any of the various modifications of it, not only is the above intranasal opening made, but an incision is also made through the buccal mucous membrane covering the upper alveolus and a varying amount of bone is removed to explore the antrum anteriorly. The buccal opening should be only of a temporary nature and is useful in that it enables the surgeon directly to inspect the antral cavity, and to make the nasoantral opening larger and more complete. If the antrum is filled with polypi, it is only by means of this approach that they can be satisfactorily cleared. Under no circumstances should forcible syringing be applied to an infected nasal cavity while the patient is under a general anæsthetic or in the recumbent position owing to the danger of spreading the infection to other cavities.

Operations for Malignant Disease of the Nasal Fossæ. Most simple intranasal conditions can be dealt with by purely intranasal operations, but in certain cases and in cases of early malignant disease where there is a reasonable prospect of cure by excision, a better view of the operation field is obtained by one of the following methods. At the same time, if the disease is found to be rather more extensive than was at first suspected the scope of the operation can be increased readily.

(1) **Rouge's Operation.** The nasopharynx may be plugged or intratracheal anæsthesia may be employed, or both these safeguards against hæmorrhage may be made use of.

The upper lip is everted by an assistant and an incision through the buccal mucous membrane is made straight down to the bone on a line extending between the first molars on either side and at a level just below the reflection of the mucous membrane from the alveolar processes of the superior maxilla on to the lip. By means of a periosteal elevator the soft tissues are separated in an upward direction until the orifices of the nasal fossæ are brought into view. The cartilaginous septum is divided, the attachment of the alar cartilages to the bone severed, the cheek on each side is separated further upwards at the same time, and the nose, lips and cheeks are turned up and everted in one mass, so that a good view is obtained of the nasal cavity. From this point the operation will depend on the disease to be dealt with, but a large part of the floor of the nose or lateral walls can be removed by this means. The septum may be removed entirely and the sphenoid explored. At the finish of the operation the whole flap, including the nose, is turned down again and only requires a few stitches to retain it in position.

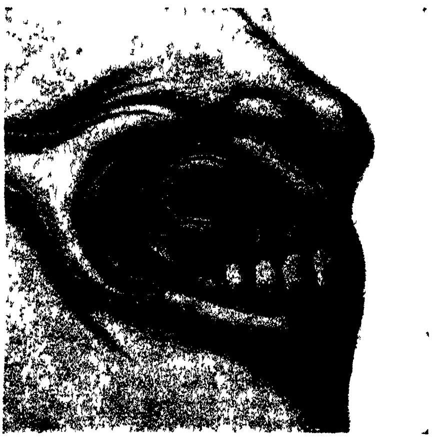

FIG. 112. Showing the exposure of the maxillary antrum in the Caldwell-Luc operation.

(2) **Moure's Operation.** The anæsthetic should be administered intratracheally, the nasopharynx should be plugged, and half an hour before the operation the affected side of the nose should be packed with gauze wrung out in a solution of cocaine 5 per cent., adrenalin 1 in 1000 (equal parts).

An incision is made from just internal and anterior to the inner canthus downwards along the side of the nose through skin and periosteum until it enters the lower margin of the nasal orifice. A second incision is carried along the lower margin of the orbit from the commencement of the first as far outwards as the malar eminence. The side of the nose is detached and retracted across the middle line, and by means of a periosteal elevator the triangular cheek flap is turned downwards and outwards. The nasal process of the frontal bone, the nasal bone and the canine fossa are stripped of periosteum. The lachrymal sac is defined, freed and retracted towards the orbit. A chisel is driven through the nasal process of the frontal bone, and also through the malar process of the superior maxilla close to its junction with the malar bone, and the lower margin of the latter incision is carried downwards and inwards across the canine fossa to the pyriform fossa. This mass of bone, including the nasoantral wall, is further freed in a backward direction and removed with lion forceps. A large deep wound is now exposed and the remaining tissue may be dealt with as desired by means of curetting, scraping, etc. The inner wall of the orbit may be removed with all the ethmoidal cells up to the cribriform plate, and the lower wall of the orbit also can be dealt with. Where possible the lower wall of the orbit should be left intact, as the eyeball is inclined to sag downwards subsequently if left unsupported.

A malignant growth can be dealt with as far back as the sphenoidal sinus, and the nasal septum can be completely resected if necessary. To close the wound all that is required is to suture the skin incisions, and it is usually advisable to leave a plug impregnated with bismuth subgallate or some similar aseptic preparation packing the cavity for twenty-four hours. This may then be removed through the external orifice of the nose.

One advantage of Moure's incision is that it can be modified easily, the horizontal limb of the incision can be dispensed with until the nasal fossa has been explored and the possibility of complete removal of the growth by operation decided upon. Also the incision may be carried down from the nasal orifice through the lip, as for excision of the superior maxilla, and this operation itself may be proceeded with if it is found that the growth has invaded the hard palate. The skin incision invariably heals remarkably well, and in a few months is difficult to detect, the only danger being a fistula following non-union close to the inner canthus if the growth has approached near the surface at this point.

(3) **Nelaton's operation** consists in approaching the nasopharynx from the mouth. The uvula and soft palate are slit in the midline and the incision is carried forward along the centre of the posterior half of the hard palate down to the bone ; from the end of this incision two others are made slightly obliquely outwards towards the teeth and the two rectangular flaps are turned outwards, including the periosteum. As much of the posterior half of the bony vault is removed as will allow of easy approach to the nasopharynx. The two flaps are united by sutures in the ordinary way. It will be necessary to do a preliminary tracheotomy before attempting this operation. Nelaton's operation is seldom performed in this country, as some modification or extension of Moure's operation is more satisfactory.

Plastic operations on the nose. The three commonest conditions for which operations are required for repairing deformed or destroyed noses are :—

1. Destruction due to trauma.
2. Syphilitic deformity.
3. Destruction due to lupus or malignant disease.

In all cases in which it is intended to carry out a plastic operation it should be explained carefully to the patient that several operations may be necessary, and that his co-operation will be required by his showing patience under the somewhat tedious treatment. Fortunately patients who request plastic treatment are nearly always prepared to help the surgeon in every way possible.

It is, of course, essential that the disease causing the deformity is completely and finally arrested before plastic surgery is commenced.

Various operations are performed according to the amount of deformity or destruction of the nose and surrounding facial tissue, but it will suffice here to mention two operations on the principles of which nasal plastic surgery is now based.

When healing is complete the nose will be excessively mobile, and fixation is obtained by inserting a piece of rib cartilage under the skin in the midline through an incision at the anterior end of the columella.

2. In cases in which there has been complete destruction of the nose, or in which the destruction is so severe that new tissue is required, the method employed is to turn down a flap of skin from the forehead. The incision is made as in Fig. 113, straight down to the bone, and all the tissues are raised with the flap, excepting the periosteum. The flap required must be made considerably larger than appears necessary to allow for shrinkage, and is turned downwards and carefully sutured into position, the tissues in apposition being first "freshened." When the flap has

"taken," and its blood supply is assured, the base is cut through and turned back on to the forehead to help to cover in the frontal wound, which also may be Thiersch-grafted.

Intranasal splinting and skin grafting will be required then as has been described already, and cartilage is implanted at a subsequent operation. Plastic flaps may be obtained from the patient's arm if the destruction of facial tissue is very extensive (see Ch. VII., Vol. I.).

A most useful graft is the double-pedicle or cigarette graft, consisting of both skin and subcutaneous fat, which is first of all cut, left attached at both its ends, and rolled up temporarily into a cigarette form. After ten days one end is detached and reimplanted into its new situation, and later the other end is transplanted. By repeating this process over and over again a thin fat-lined skin graft may be moved up from the chest or arm to the face or nose.

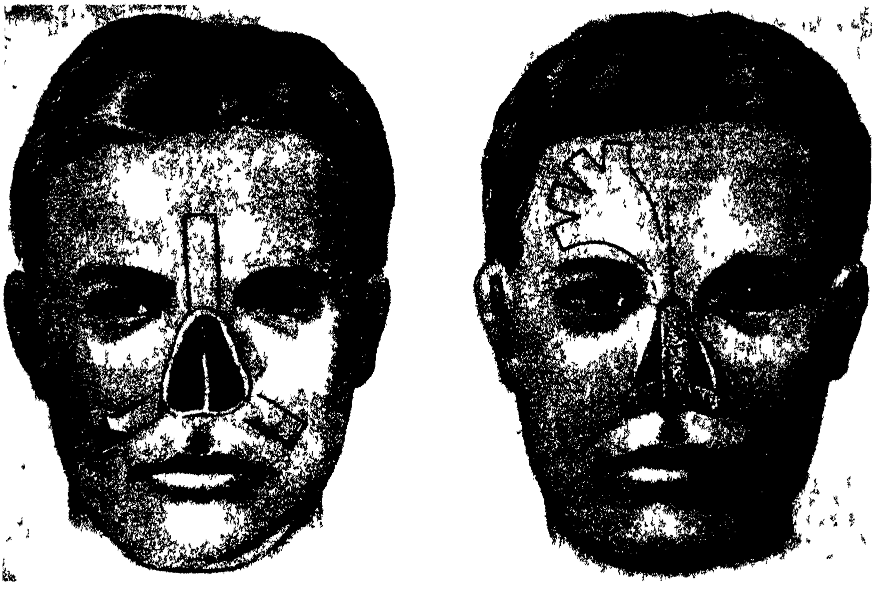
(*a*) (*b*)

FIG. 113 Diagram showing two stages in a plastic operation for reforming the nose. (*a*) Incisions marked for skin flaps to be turned back to form the deep aspect of the new nose. (*b*) Frontal skin flap marked out preparatory to being turned down, so that the raw surface is opposed to that of the flaps in figure (*a*).

THE EAR

Surgical Anatomy of the Ear.

The Auricle. The skin covering the auricle is tightly bound down to the perichondrium, and therefore its inflammation is attended with little swelling but much pain. The blood supply of the auricular cartilage is poor, and it is liable to slough if severely damaged.

The external auditory meatus, the general direction of which is successively inwards, forwards, upwards and downwards, possesses a narrowing in the centre of the bony portion (inner two thirds) which is of practical importance in that a foreign body may become impacted beyond it.

The skin of the osseous portion is thin and fused with the periosteum, hence chronic inflammation may lead to periostitis and osseous narrowing.

Anteriorly and inferiorly the osseous canal is related to the temporomaxillary articulation and to the parotid gland. Pain on mastication is frequently complained of in acute inflammatory affections of the meatus and middle ear, especially in children, in whom the tympanic plate is incompletely ossified.

The appearance of the tympanic membrane is described in the examination of the ear (see p. 320).

The middle ear consists of three parts: (1) the Eustachian tube, (2) the tympanum, (3) the mastoid antrum and air cells.

The Eustachian tube is one and a half inches long and runs downwards, forwards and inwards from the ear to its opening into the nasopharynx. This opening is situated roughly half an inch behind the posterior end of the inferior turbinal and half an inch above the floor of the nasal fossa in its lateral wall, the entrance into the nasopharynx being guarded above and behind by a folded-over pad of cartilage, the Eustachian cushion.

In a child the tube is relatively shorter, wider and more horizontal, and therefore more liable to allow of an extension of infection along it from the nasopharynx.

The two important facts to remember in connection with the surgical anatomy of the **tympanum** are its short lateral dimension and that all the important structures in it are situated above the horizontal diameter of the tympanic membrane.

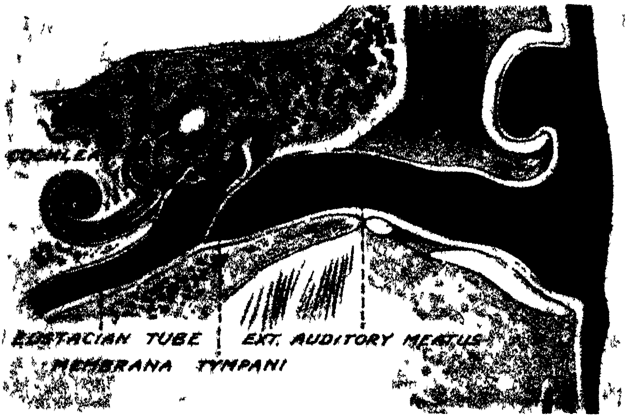

FIG. 114 An anteroposterior section through the ear.

For this reason the operation of paracentesis of the membrane is performed quite safely in the postero-inferior quadrant.

The attic or epitympanic space is that part of the tympanic cavity extending above the upper level of the tympanic membrane and posteriorly it is continuous with the **aditus of the antrum** leading into the mastoid antrum.

The mastoid antrum is a retort-shaped extension of the tympanum, and like it is lined throughout with ciliated epithelium. It is about a third of an inch in diameter, and in the adult situated at a depth of about three-quarters of an inch from the surface, just above and behind the external meatus, deep to Macewen's triangle.

The *outer wall* of the antrum is formed by bone which lies beneath the triangular area in the angle formed by two lines drawn as tangents to the roof and posterior wall of the bony meatus respectively (Macewen's triangle). This serves as a guide for the commencement of an operation performed for opening the antrum. The *roof* of the antrum is formed by the posterior part of the tegmen tympani, sometimes known as the tegmen antri, a thin plate of bone which separates it from the middle cranial fossa.

The *inner wall* of the antrum is formed of thick spongy bone in which is situated the posterior semicircular canal.

The *floor* is on a lower level than the aditus and, therefore, unfavourably situated for natural drainage.

The mastoid antrum is present at birth, and is then almost of adult size. It is, however, much nearer the surface, being covered by a thin plate of bone not more than about one millimetre in thickness. The outer bony wall increases at the rate of roughly one millimetre a year up to the age of ten.

The mastoid process is not present at birth and only begins to develop in the second year. As development proceeds the diploë surrounding the antrum in the child becomes excavated to form the *mastoid air cells*, which radiate from the antrum and communicate directly or indirectly with it by means of small openings. The mastoid cells are lined with epithelium continuous with that of the antrum.

Two types of mastoid process are described:

(*a*) The *pneumatic type*, in which the whole of the process is excavated by these cells in all directions and even as far back as the occipital bone.

(*b*) The *sclerosed type*, in which cells are absent and the whole process consists of hard solid bone.

In the pneumatic type, following an acute infection of the antrum, the cells may become involved in all directions and the inflammation spread externally or backwards to the lateral sinus.

In the sclerosed type the spread of infection is more likely to be driven inwards.

The **facial nerve** runs backwards in the Fallopian aqueduct just above the foramen ovale, and it is here covered by a very thin plate of bone. It then turns downwards and slightly backwards, behind and below the aditus, and reaches a position about one-eighth of an inch below and internal to the deepest part of the posterior wall of the osseous external meatus. In any of these situations it is liable to injury during a radical mastoid operation.

EXAMINATION OF THE EAR

This is carried out (1) by inspecting the tympanic membrane through an ear peculum by means of light reflected from a frontal mirror. An electric auroscope is a convenient type of instrument for examining the external meatus and the drum membrane.

(2) By testing the power of hearing.

(3) By ascertaining whether or not the Eustachian tube is permeable and by noting the effect on the hearing produced by inflation of the middle ear through this tube.

FIG. 115. A normal right tympanic membrane.

(1) The tympanic membrane (Fig. 115) is inspected by means of an aural speculum which is introduced gently into the external meatus with one hand, while the other hand is used to pull the cartilaginous part of the meatus upwards and backwards by traction on the pinna. The source of light is to the left-hand side of the patient and similar to that used for examination of the nasal fossæ, and an exactly similar frontal mirror is required. Once the speculum is in position it can be held there with one hand, while the other is free for any other further purpose in the course of the examination. The membrana tympani will at once be seen unless wax, epithelial debris or pus are present to obstruct the view, in which case they must be removed, either by syringing or by cotton wool mops held in specially made aural dressing forceps. In examining the drum membrane its relative position, colour, thickness and light reflex are to be determined. The long process of the malleus is the most prominent landmark on the drum, and is to be seen running downwards and backwards to the umbo or centre of the membrane, to which it is here attached. Owing to the external concavity of the drum a cone of reflected light will be observed triangular in shape, with its apex at the umbo and its base at the antero-inferior periphery. Variations in the lustre of the drum are of marked diagnostic significance, and any inflammation is at once shown by the appearance of injected blood vessels in the surface of the membrane which are not visible in the normal drum. If the inflammation is at all acute the drum becomes bright red in colour.

At the base of the long process of the malleus the projection in the drum produced by the short process of the same bone can be seen readily, and between this point and the periphery is situated Shrapnell's membrane.

(2) The investigation of the hearing is carried out by a variety of methods, into details of which it is not necessary to go here. The simpler methods, however, may be described.

(*a*) The patient may be tested as to the distance at which he can answer questions put in an ordinary conversational voice. One ear can be excluded at a time, either by an assistant or by the patient pressing the moistened tip of one finger into the external meatus.

(*b*) The perception of the whispered voice may be tested.

(*c*) The exact distance can be noted at which a patient can hear the ordinary tick of a watch, the ears again being examined separately and the results compared with the hearing of a normal individual.

(*d*) *Rinné's tuning fork test* is carried out by means of a tuning fork of between 500 and 600 vibrations a second. The fork is made to vibrate and placed in contact with the mastoid process and retained there until the patient can hear it no longer. As soon as the patient says he can no longer distinguish the note the prongs of the fork are held opposite the external meatus, when the sound should be heard distinctly again if the ear is normal. If there is disease of the sound-conducting apparatus, as in middle ear catarrh or suppurative otitis media, the tuning fork can be heard longer when in contact with the mastoid process than it can when the vibrations are being transmitted to the sound-perceiving apparatus by air conduction only. In a normal ear Rinné's test is said to be positive, but if the bone conduction is longer than the air conduction of sound, Rinné's test is said to be negative. In cases of pure nerve deafness, although hearing both by bone conduction and air conduction is much diminished, Rinné's test will be found to be positive.

(*e*) *Weber's test* consists in placing a vibrating tuning fork in contact with the middle line of the forehead. In cases of pure middle ear disease (*i.e.*, when the apparatus for transmitting air waves or sound is defective) the sound will be louder in the affected ear than on the healthy side.

(3) Inflation of the tympanic cavity is carried out in three ways :—

(*a*) *Valsalva's method* consists in the patient closing his lips, holding his nose and expiring forcibly ; if the Eustachian tubes are patent, air is driven into the cavity under pressure.

(*b*) In *Politzer's method* an indiarubber bag with a teat-shaped end is introduced into one nostril so as to occupy it completely, the other nostril being closed by the surgeon's finger. The patient is instructed to take a sip of water and to hold it in the mouth with closed lips until told to swallow. As he swallows, the bag is forcibly compressed and air is driven up the Eustachian tubes if they are patent. An auscultating tube may pass from the patient's external meatus to the surgeon's ear and various sounds, such as whistling, clicking, bubbling, etc., noted, according to the character of the lesion.

(*c*) *Eustachian Catheter.* For the purpose of more accurately inflating the Eustachian tube, or if it is desired to inflate one side only, the Eustachian catheter may be employed. This consists of a fine silver tube with a bend in it, the end of which can be introduced into the entrance of the Eustachian tube via the inferior meatus of the nose. The method of passing it will not be described here, as it should only be employed by an expert otologist.

Deafness. Before describing the commoner diseases of the ear it would be as well to mention shortly the etiology of deafness.

Deafness may be either (1) total, or (2) partial.

(1) **Total Deafness.** (*a*) *Congenital.* Total congenital deafness is usually associated with some anatomical abnormality of the sound-perceiving apparatus, but this is not always the case. Children born totally deaf are unable to learn to speak and belong to the class of deaf mutes. The children of consanguineous marriages furnish a considerable proportion of all forms of congenital deafness. Syphilis is another common cause of congenital deafness. No treatment is of any avail in this condition, but by means of special education the children may learn to phonate sufficiently well to make themselves understood in conversation.

(*b*) *Acquired.* Total deafness is the result of destruction of part of the hearing apparatus by disease or injury after birth, and may be present in one or both ears. Among the commoner causes are fracture of the skull, involving the internal ear, severe concussion, cerebrospinal meningitis, mumps, syphilis, senile degeneration, and catarrhal or suppurative otitis media. In infants destruction of the middle or internal ear on both sides may result from suppurative otitis media following scarlet fever or following cerebrospinal meningitis, in which case, if the child is under the age of five, deaf-mutism very likely will ensue.

(2) **Partial deafness** is nearly always acquired, and is due to disease or traumatism either of the sound-conducting apparatus or of the internal ear. There is often an hereditary tendency to some of the acquired forms of deafness.

THE EXTERNAL EAR

Under this heading is included the auricle and the external meatus.

(1) **The Auricle.** The auricle may be the site of any lesion to which the skin elsewhere is liable, and the treatment in no way differs from that which is described in Ch. IX., Vol. I.

The auricle may be absent congenitally, but more commonly one or more **accessory auricles** are present. No treatment is required in the former case, but if the accessory auricles are noticeably large in size they may be removed by a small plastic operation. They are situated anterior to the external meatus and resemble a small, rather firm fibroma. Large and prominent ears may constitute a very unsightly deformity, due either to their size or only to their prominence (**lop ear**). If a patient is worried by the deformity caused by a prominent ear it can be much reduced by a simple operation; *i.e.*, removing an area of skin on the dorsum of the auricle and a corresponding area on the side of the head and suturing the borders of the incisions to each other. To reduce the size of an enlarged auricle a V-shaped portion should be removed from the upper part, and at the same time any prominence caused by redundant cartilage is dealt with by excising a portion of the cartilage subcutaneously. The wounds caused must be sutured together accurately and extra care should be taken in regard to surgical cleanliness, it being remembered that the blood supply of the auricle is poor, that the skin covering it is difficult to sterilise, and that suppuration is likely to be followed by unsightly scarring. Large hæmatomata of the auricle as a result of minor injuries are sometimes seen. They are said to be especially common in lunatics.

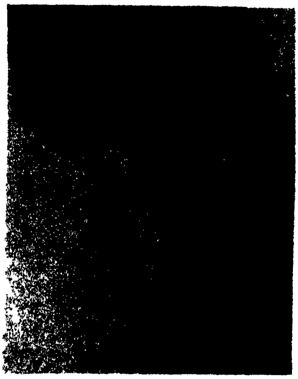

Fig. 116.—Haematoma of ear.

The auricle is especially liable to **eczema**, which may be either acute or chronic. In the acute stage the affected part should be bathed frequently with a solution of subacetate of lead (1 drachm to 4 fluid ounces of water), and at the same time the ear should be protected from external irritation. In other cases the following dusting powder suits very well :—

℞ Amyli, ʒiii
Zinci oxidi, ʒi
Calaminæ, ʒi

In the chronic stage astringent and stimulating remedies are usually indicated, and these are best applied in the form of ointments containing resorcin, salicylic-acid, or ichthyol.

Where crusts are difficult to remove it may be necessary to saturate them with weak carbolic acid and then apply a milder stimulating ointment such as benzoated oxide of zinc ointment or boracic acid and vaseline.

(2) **The external auditory meatus** is lined throughout by skin, which is

firmly adherent to the underlying cartilage and bone. In the deeper part of the meatus are the glandulæ ceruminosæ, which secrete the ear wax or cerumen. These are really modified sweat glands.

In some people there is a tendency for this secretion to be excessive, and a plug of wax collects in the lumen of the meatus (**wax obstruction**).

The symptoms produced by the presence of such an obstruction are deafness and tinnitus, the deafness usually coming on quite suddenly when bathing owing to the plug swelling from moisture and finally completely occluding the meatus.

The impacted cerumen can be safely removed only by syringing out the meatus with warm water from a special metal ear syringe containing about four ounces of water, the stream being directed along the roof of the meatus. A fair amount of force is necessary, and bubbles of air should not be forced in with the water owing to the very unpleasant sensation produced on the patient. Cold water should on no account be used as it irritates the labyrinth and may cause myringitis. If the plug cannot be dislodged it should be softened by pouring in about half a teaspoonful of warmed hydrogen peroxide (10 volumes) two or three times during twenty-four hours and the syringing again carried out.

Foreign bodies, such as buttons, beads, peas, etc., may become impacted in the meatus, and a preliminary attempt always should be made to remove them by means of syringing as for cerumen. If this fails, and the object is in the deep part of the meatus beyond the narrower portion of the canal, or if the walls of the meatus are inflamed and swollen as a result of irritation, some form of instrument must be resorted to. Under such circumstances, especially in the case of a child, a general anæsthetic should be administered. Great care must be taken not to injure the delicate tympanic membrane during this operation. In some cases it will be necessary to turn the auricle forwards from a posterior incision and open into the meatus through the bone from behind.

FIG. 117. Incision showing the skin area to be excised to cure a prominent auricle.

Inflammation of the external meatus (external otitis or furunculosis of the external meatus) is one of the commonest inflammatory affections of the external ear and is often associated with boils elsewhere. It is very resistant to treatment, and there is a marked tendency to recurrence. The inflammation starts in a hair follicle or gland and gives rise to very acute pain, especially on pressure. As soon as the condition is established a small fluctuating lump can be seen in the meatus, which is acutely tender, and any movement of the auricle increases the pain. The condition must be diagnosed from mastoiditis, and this is especially difficult when one of the lymphatic glands over the mastoid process becomes inflamed secondarily to external otitis. The appearance of the meatus and the acute pain elicited on moving the auricle serve to distinguish external otitis from pure middle ear inflammation. The hearing will not be affected unless the external meatus is completely occluded by the swelling.

Treatment in the acute stage is mainly directed towards relieving the pain. This is best achieved by the application of hot fomentations and frequent syringing of the meatus with hot water. It may be necessary to give morphia.

Plugs of cotton wool—soaked in a paste consisting of one part glycerine to two parts magnesium sulphate—may be inserted in the meatus and changed every few hours. If it is decided to incise the furuncle, the operation should be done under gas anæsthesia, so that the inflamed tissue can be opened up thoroughly.

Where the condition runs a more chronic course, general treatment is indicated, and at the same time the meatus should be treated with a mild antiseptic. The following oily solution, warmed,

℞ Ung. hydr. nit. dil. grs. x
Ol. Amygdalis }
Ol. Olivæ } aa ℥ss

should be instilled three times a day, a few drops at a time.

Eczema of the external meatus must be treated on the same lines as that mentioned in the treatment of eczema of the auricle.

Exostoses are occasionally met with projecting from the wall of the meatus and must be distinguished from impacted cerumen, the presence of a foreign body or a furuncle. Unless giving rise to deafness or inflammation they are best left alone, but if treatment is decided upon they may be removed by a posterior incision similar to that for mastoiditis, great care being taken to keep the wound sterile. Subsequent scarring is likely to lead to atresia of the meatus unless it is packed regularly with aseptic plugs until healing has taken place. The operation may be a very difficult one (see also p. 86), as these exostoses are always particularly hard and ivory-like.

The Membrana Tympani. This may be ruptured or may become acutely inflamed as a result of exposure or local irritation and trauma. **Rupture** may be due to (1) direct violence, (2) indirect violence.

(1) When due to direct violence it results from the introduction of a foreign body into the meatus or from unskilful efforts to extract such a body.

(2) Rupture of the membrane due to indirect violence may follow a blow on the ear or a sudden violent explosion, and it may or may not be accompanied by labyrinthine concussion and complete temporary or permanent deafness.

Fractures of the base of the skull are frequently accompanied by rupture of the membrane and the free escape of cerebrospinal fluid and blood.

The rupture can be diagnosed only by direct inspection. In the cases due to direct violence it may be advisable to disinfect the meatus by means of hydrogen peroxide, but if the rupture is the result of indirect violence syringing or the use of lotions must be avoided, an antiseptic ear pad applied, and the rupture left to heal by first intention.

Recovery of hearing is almost always complete, unless suppuration follows or unless any accompanying damage to the delicate labyrinth has occurred.

Acute myringitis is the result of exposure to cold, the entrance of cold water to the ears as occurs in bathing, trauma, or an extension of acute external otitis.

The drum is seen to be inflamed, congested and swollen, and pain is severe. There is no diminution in hearing, and this feature helps to distinguish the condition from tympanic inflammation.

Treatment consists in applying heat and the instillation of warm drops of a 5 per cent. solution of glycerine of carbolic acid, which serve the double purpose of rendering the tissues aseptic and relieving the pain.

ACUTE INFLAMMATION OF THE MIDDLE EAR

The term "middle ear" comprises the whole length of the middle ear cleft which extends from the opening of the Eustachian tube in the nasopharynx through the Eustachian tube, tympanic cavity, attic, aditus and mastoid antrum to the air cells in the mastoid process.

Inflammation of the middle ear is an exceedingly common affection, and constitutes the great bulk of all ear diseases. The Eustachian tube being continuous with the nasopharynx, the cause of acute otitis media is almost invariably a direct extension of infection along the tube, and the organisms present with suppuration are usually pneumococci or ordinary pyogenic cocci.

In considering acute otitis media it is necessary therefore to remember that it is an inflammation of the whole or any part of this tract, either catarrhal and serous, or suppurative and purulent in nature.

Acute inflammation is more common in children and is usually secondary to some lesion of the nasopharynx, such as an ordinary cold. Children suffering from adenoids are especially liable to this condition. Children or adults in a debilitated condition or infected with any of the acute exanthemata are particularly prone to middle ear inflammation, and under these circumstances suppuration usually results. At any stage in the course of scarlet fever middle ear infection may be met with, and in this disease the resultant damage to the hearing apparatus is often severe.

Acute otitis media may be divided into the following classes for the purposes of description, although in a case of acute suppurative inflammation of the whole middle ear cavity all the different stages may have been present at different times as the infection progressed.

(1) **Acute catarrh of the Eustachian tube and tympanum** with serous effusion.

This condition is met with usually as the result of cold in the head. The Eustachian tube becomes partially blocked, there is some serous effusion in the tympanum, and the patient complains of partial deafness, a continuous noise in the affected ear, and a feeling of fulness and discomfort, but little or no pain.

Treatment aims at relieving the Eustachian obstruction and assisting the absorption of the exudate; it therefore follows that any infection or congestion of the nasopharynx must be combated. Any treatment beyond this should be entrusted to an otologist. The condition usually takes a week or two to subside.

(2) **Acute catarrhal otitis media,** with serous effusion and the presence of a few pus cells, which may or may not be followed by rupture of the tympanic membrane.

The inflammation here is more acute and severe than in the preceding type, is accompanied by hyperæmia and swelling of the mucous membrane, and pain is usually present from the commencement. When the inflammation is established pain is severe and deafness marked. In children the temperature is usually raised. On examination the membrana tympani appears injected and swollen, and if there is much intratympanic tension it may be bright red and bulging externally. The inflammation may subside in the course of a few days or the membrane burst and release the mucopurulent secretion, this being followed by relief of pain and subsequent resolution and healing of the rupture.

Treatment consists in relieving the pain, which should be done by the application of dry heat and the administration of analgesics. Morphia may be required before relief is obtained. If the pain and the tympanic condition persist, paracentesis of the membrane should be performed. This is carried out under a general anæsthetic, and by the use of a special paracentesis knife or myringotome under direct observation. The incision is made tangentially through the posterior segment of the membrane. Following this operation and subsequent drainage by suction through the external meatus the duration of the inflammation will be shortened considerably and the danger of extension of the infection to the mastoid antrum much reduced. The hearing should return to normal within two or three weeks.

(3) **Acute suppurative otitis media** means that the formation of pus in the tympanum is established almost at the onset. For practical purposes of diagnosis and treatment the condition may be divided into two classes:—

(*a*) That in which the inflammation has not extended into the mastoid antrum.

(*b*) That in which the mastoid antrum and air cells are also infected. In this connection it should be stated that mastoid inflammation may occur without any evidence of inflammation of the tympanum being present.

(*a*) **Acute suppurative otitis media without mastoiditis.** Pain is the first and most prominent symptom, and increases from the onset of the disease up to the time when rupture of the tympanic membrane takes place. There is pain and tenderness over the mastoid process in the early stages, but this passes off following rupture of the membrane, and unless the antrum becomes infected does not recur. The degree of deafness varies, but evidence of the obstructive form of deafness is always present. There may be some tinnitus. The temperature rarely rises above 100° F. except in the case of young children.

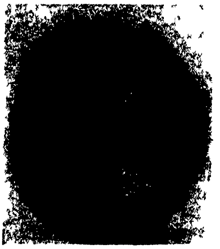

FIG. 118. Line of incision for paracentesis.

The following intracranial complications may accompany an acute purulent otitis media, even in the absence of mastoiditis: (1) labyrinthitis, (2) extradural abscess, (3) lateral sinus thrombosis, (4) meningitis, and even purulent encephalitis. These are described in Chapter I., pp. 29—42, with the exception of the first (see p. 334).

If an examination is carried out before rupture of the drum has occurred it will be seen to be inflamed, injected, and may be bulging very prominently into the external meatus. In the event of rupture already having taken place the meatus is found to contain seropurulent or purulent fluid, and after this has been mopped out the perforation usually can be seen in the membrane. If it cannot be recognised at once, on watching, a pulsating bead of pus will be seen to form at the point where the hole is situated. When the rupture of the membrane takes place all the symptoms are immediately relieved, and if the condition passes off normally the perforation closes, drainage through the Eustachian tube is re-established, and the tympanic membrane returns to normal appearance in a few weeks, an area of opacity being the only indication of the lesion. The only difficulty in diagnosis is that of differentiating furunculosis of the external meatus from acute otitis media. Deafness is much more noticeable in otitis media, and if the whispered voice can be heard at two yards middle ear inflammation can almost certainly be excluded, but it should be borne in mind that the two conditions may coexist.

Treatment in the early stages consists in relieving the pain by the administration of analgesics and the application of heat. Some aurists advise frequent gentle douching of the meatus with hot water, the ear being covered between the douchings. The most effectual measure for the relief of pain is paracentesis of the tympanic membrane. The indications for the performance of this operation are (1) severe pain and bulging of the tympanic membrane, (2) pain continuing after spontaneous rupture of the membrane and with a very small perforation allowing inefficient drainage, (3) marked pyrexia with signs of cerebral or labyrinthine irritation.

After perforation has occurred or paracentesis has been performed treatment must be continued on the following lines. Hot fomentations to the ear may be continued as long as pain is present. At four-hourly intervals the patient's head is placed on one side with the affected ear uppermost and 10 drops of hydrogen peroxide (10 vols.) are instilled into the meatus and allowed to remain for about a minute, during which time bubbles of oxygen are given off. The patient then sits up and the ear is gently syringed out with warm water, followed by careful mopping up of the moisture within the meatus until it is dry. The object of this is to prevent pus stagnating in the meatus. If the discharge is not profuse the syringing need not be carried out every time the hydrogen peroxide is used, but the meatus must be kept clean by frequent mopping. In order to aspirate the secretion from the tympanic cavity, suction by means of a Siegle's speculum may be employed. In the event of the discharge persisting for more than a few days other drugs may be applied to the aural mucous membrane, but it is essential to remember that whatever is applied careful preliminary cleansing of the auditory meatus is necessary.

(1) Alcohol may be applied mixed with water and glycerin.

S.V.R.	℥ss
Glycerin	ʒi
Water	to ℥i

or ordinary spiritus vin. rect.

Either of these will cause pain if the inflammation is at all acute.

(2)	Glycerin of carbolic acid . . .	2 or 3 drachms
	Water	to ℥i

This is useful if pain is caused by other applications.

(3) Hypertonic saline (10 per cent.) is useful but should not be used for more than two or three days.

(4) Instead of drops finely powdered boracic acid (with 1 per cent. of powdered iodine crystals added) may be packed into the meatus and left for a day or two at a time. The meatus being carefully syringed and cleaned between each packing.

If the discharge has not shown definite decrease and improvement within three to four weeks of onset the mastoid antrum and cells should be opened and drained.

The *prognosis* is favourable if the general health of the patient is good, and if efficient treatment is carried out acute suppurative otitis media should become chronic very rarely. In most cases the hearing returns to normal after the attack, but otitis media as a complication of one of the infectious fevers is not so favourable as other forms.

(b) **Acute Mastoiditis.** During the course of an attack of acute middle ear inflammation the surgeon should examine the mastoid process frequently for œdema or tenderness. The thumb of the right hand is pressed against the

process, and the degree of tenderness to pressure noted and compared with that on the healthy side. Particular care should be taken to examine the tip of the mastoid process and its posterior border in this way. If the pain and tenderness over the mastoid process increase or recur during the course of an attack of acute otitis it is almost certain that the mastoid inflammation will not subside unless an operation is performed.

Pathology of Acute Mastoiditis. The mucous membrane lining the antrum and air cells becomes swollen and infiltrated and the purulent exudate accumulates in the cavities. If this purulent exudate is unable to escape owing to the congestion produced in the aditus, the inflammatory process spreads and invades the surrounding bone. This may occur slowly or rapidly, according to the virulence of the infection or the resistance of the patient, but in some cases the condition of mastoid abscess does not become established for several days. Attention has been drawn already to the different types of mastoid process and their bearing on the question of mastoiditis. If the tension in the antrum is unrelieved, the pus eventually bursts through the shell of bone surrounding it in one of several directions.

(1) An abscess forms under the periosteum covering the process, giving rise to a fluctuating external swelling, displacing the auricle in a forward, outward and downward direction.

(2) The abscess may burst through the inner aspect of the mastoid process, giving rise to an abscess in the neck beneath the sternomastoid muscle and anterior to it (*Bezold's abscess*).

(3) Very rarely the pus tracks down into the neck on a deeper plane and gives rise to a bulging of the lateral pharyngeal wall.

(4) More frequently the inflammation spreads backwards and forms an abscess between the posterior surface of the mastoid and the dura mater covering the lateral sinus (*perisinus abscess*).

(5) In the same way an extradural abscess of the middle cranial fossa may result as a direct extension through the roof of the tympanic cavity or mastoid antrum.

It is therefore essential to drain the mastoid antrum by operation as early as possible in order to prevent any of these complications occurring and in order to limit the area of diseased bone. Naturally the least dangerous direction for the pus to burrow is in an outward direction, and fortunately this is the most common.

Indications for the Mastoid Operation. (1) Mastoid tenderness continuing or recurring after drainage has been established by perforation of the tympanic membrane. As the tenderness develops it is often noticed that there is a diminution or even total cessation of the aural discharge owing to the antrum becoming shut off, and this is of some diagnostic importance.

(2) Œdema or abscess formation over the mastoid process or formation of a Bezold's abscess.

(3) Sagging or œdema of the posterior wall of the external meatus.

(4) Fever (*i.e.*, temperature of over 100° F.) persisting after perforation or paracentesis.

(5) Paralysis of the facial nerve during the course of acute purulent otitis media. This condition indicates that the bone surrounding the nerve in the facial canal has become inflamed or infected.

(6) Any symptoms of labyrinthine or intracranial irritation or infection, such as giddiness, vomiting and nystagmus.

(7) Persistence of the aural discharge for more than six or seven weeks in spite of efficient conservative treatment.

Operation for Acute Mastoiditis. The patient's hair is shaved and a convenient area round the ear cleared. A general anæsthetic is administered, the patient lying on his back, the head slightly raised by means of a soft sandbag and turned to the side so that the affected ear is uppermost. As the operation proceeds it will be found necessary for the surgeon to be provided with frontal illumination. The skin of the ear and operation field is carefully cleaned and sterilised. The auricle is turned forward and a curved incision is made down to the bone, parallel to the retro-auricular groove and quarter of an inch distant from it. This incision should extend downwards slightly beyond the tip of the mastoid process. (In infants and young children it is possible to injure the facial nerve close to the tip of the mastoid process if reasonable care is not taken.) The superficial vessels are caught, the periosteal incision completed, and the periosteum stripped up with an elevator so that the mastoid cortex is exposed as far down as the tip of the process and upwards and forwards to include the posterior root of the zygoma and the suprameatal spine. A self-retaining retractor may be placed in position or an assistant retract the tissues. The mastoid cortex is opened with a gouge and hammer, starting at a point level with the roof of the external meatus and about ½ inch behind its centre, the gouge cuts being made from behind downwards and forwards, *i.e.*, from the region of the sigmoid sinus towards the external meatus and mastoid tip, the assistant in the meantime mopping up blood and pieces of detached bone. The bony cavity thus formed is deepened in the direction of the suprameatal triangle until the mastoid antrum is reached (the surgical anatomy of the antrum has already been considered, p. 319).

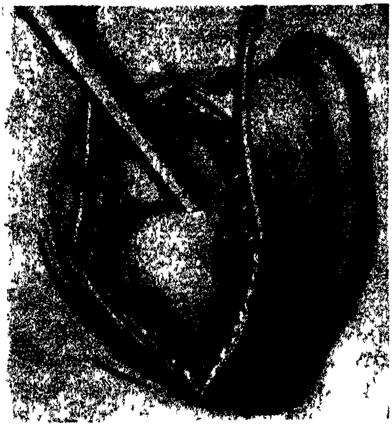

FIG. 119. Operation for acute mastoiditis, showing the gouge in position to commence removal of the bone over the antrum.

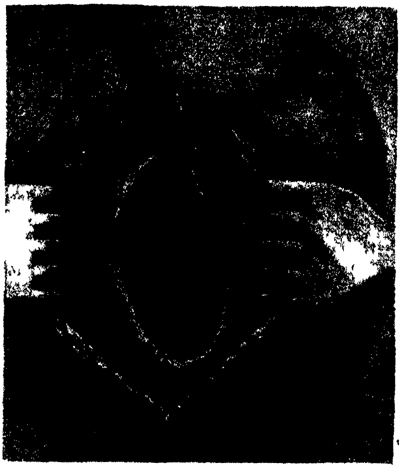

FIG. 120. Operation for acute mastoiditis, showing the mastoid cells cleared and a director passed through the aditus from the antrum to the tympanum.

As soon as the infected cells are opened the pus retained wells up, but it must be remembered that infected mastoid cells do not necessarily contain pus under pressure. The antrum is mopped clean and the opening into it enlarged and all diseased bone removed. It is usually necessary to clear out all the mastoid air cells down to the tip of the process, and it may be necessary to expose the lateral sinus posteriorly and the cerebral dura mater superiorly in order to eliminate the possibility of abscess formation in these localities. In the event of a perisinusal abscess or an extradural abscess being discovered the bone must be removed freely in these situations in order to establish drainage. When exposing the dura mater in any situation it is advisable to make the gouge cuts at a very oblique angle to the surface and as nearly as possible in the same plane as the membrane. When this is done there is very little danger of injuring the dura. If there is reason to suspect the existence of a cerebral abscess, the dura in the region of the roof of the antrum is freely exposed, and incised. The middle cranial fossa can be then explored and drained. In the same way if a track of infection is found posteriorly and a cerebellar abscess has been diagnosed, the bone is cut away behind the lateral sinus and a sufficient area of dural membrane exposed. In order to do this it will be necessary to make another horizontal backward skin incision at a right angle to the original incision.

When the cavity is complete it is washed out with hydrogen peroxide (20 vols.) and syringed with warm saline solution.

The subsequent treatment of the wound varies according to the methods of different surgeons or according to the virulence and extent of the infection.

1. The cavity may be packed with a sterile gauze plug or a plug impregnated with iodóform or aristol, and only one or two stitches or even no stitches at all inserted in the upper end of the incision. A dressing and bandage is applied and the plug left in position for four days, the external meatus being kept clear in the meantime by daily cleansing. When the plug is removed, and it may be necessary to administer an anæsthetic to do this, another is packed in its place after the cavity has been cleansed with weak hydrogen peroxide, the procedure being repeated daily and the wound allowed to granulate from the bottom. This aims at obliteration of the cavity by scar tissue.

2. A plug may be inserted as described above and removed in two or three days. Drainage is then maintained by the insertion of a rubber tube which is changed daily but retained until the meatal discharge has ceased. The advantage of this method is that it allows for posterior drainage of the ear cavity, one of the main objects of the operation.

3. When all the diseased tissues have been thoroughly removed (and this of course applies in all cases) the cavity is syringed out with saline, dried out, and allowed to fill with blood. The wound is then united through its whole length and a dressing applied. It is claimed that in the great majority of cases healing occurs by first intention owing to the bactericidal powers of the effused blood. If pus forms in the cavity it can be evacuated by removing a few stitches in the lower part of the wound and ordinary drainage established in that way.

Serous Meningitis is a subacute form of meningitis often seen in association with an acute infection of the ear. No actual infection occurs in the meninges and the process is more one of irritation than inflammation. Headache, rise of temperature, and drowsiness are the chief symptoms noticed, while paralyses of the cranial nerves and localising features are absent. The condition is not serious, and requires no special treatment other than that of the ear infection itself, which should be dealt with promptly.

Lateral sinus thrombosis may occur as an extension of infection from the mastoid process. This complication is usually indicated by the occurrence of rigors, due to the passing of infected matter into the blood stream, accompanied by pain and tenderness extending into the neck along the course of the internal jugular vein.

The diagnosis can be made certain only by exploration, which is always carried out as an extension from a mastoid operation.

The lateral sinus is exposed, and if normal it is bluish in colour and pulsates with the heart and respiration. Sometimes it is obviously purulent, but if there is any doubt it should be opened by longitudinal incision.

Hæmorrhage can be controlled easily by subsequent plugging. All infected clot must be removed in both directions until free bleeding occurs.

The internal jugular vein must be ligatured in the neck through a separate incision, below the inferior extension of the thrombus.

A full description of sinus thrombosis and of the other complications of acute otitis media and acute mastoiditis will be found in Chapter I., Vol. II.

CHRONIC INFLAMMATION OF THE MIDDLE EAR

Chronic Middle Ear Catarrh. This condition is one of the commonest causes of deafness. It is characterised by chronic thickening of the mucous membrane lining the tympanum and Eustachian tube due to an overgrowth of the connective tissue element, following chronic or repeated acute attacks of inflammation. The symptoms are gradually increasing deafness with or without tinnitus coming on insidiously during adult life, very often from no apparent cause. Sometimes patients notice that the deafness becomes worse after a cold in the head. There is frequently a history of adenoid obstruction during childhood.

The *treatment* cannot be dealt with here except that it may be said that attention to hygiene of the nose and nasopharynx, especially in childhood, will act as a definite preventative to the condition arising in later life.

Otosclerosis is a form of deafness apparently due neither to a catarrhal nor to a bacterial process. It is quite distinct from deafness due to degeneration of the auditory nerve.

Pathologically all that is noted is a spongification of the bone of the labyrinthine capsule and fixation of the stapes in the foramen ovale and ossification involving the membrane in the foramen rotundum. It is a disease of young adult life and usually reaches its maximum before the age of forty.

By the term "**Ménière's Disease**" is meant an acute inflammation(probably toxic) and irritation of the labyrinth producing the symptoms of tinnitus, vertigo, vomiting and nausea, followed by deafness.

A more correct name for the condition would be Ménière's symptom-complex, and this symptom-complex may be produced by any severe irritation or infection of the internal ear. It may be simply the result of reflex irritation from the middle ear, but much more usually it indicates extensive damage to the sensitive endings of the cochlear and vestibular elements of the eighth nerve.

Vertigo. A patient suffering from an attack of *vertigo* is temporarily unable to maintain his equilibrium to a varying degree.

It may be brought about by a large variety of nervous stimuli, ocular, nasal, intestinal, toxic, etc., but when associated with aural disease it is due to direct irritation of the labyrinth. It may be caused by (1) wax in the external meatus, (2) acute or chronic Eustachian catarrh, (3) otosclerosis, (4) acute middle ear suppuration, (5) chronic middle ear suppuration, and (6) labyrinthitis.

Its occurrence during the course of any aural suppuration should be taken as a warning that the internal ear is in danger.

Chronic Suppuration in the Middle Ear. By this is meant a chronic infection of the mucous membrane lining the Eustachian tube, tympanum and mastoid antrum, and the underlying bone. The infection may be confined to the Eustachian tube and tympanum, but frequently the mastoid antrum and process are also diseased, and this makes the condition all the more difficult to cure. As a result of this chronic infection there is a continuous discharge from the ear (otorrhœa), which varies in amount at different times and in different cases. There is always some impairment in hearing, but this varies from very slight to complete deafness and bears very little relation to the amount of destruction of the tympanic membrane. Tinnitus is usually present, and there may be attacks of vertigo.

Chronic otorrhœa is almost always the result of an acute suppuration which has failed to clear up, either through lack of treatment during the acute stage or owing to the virulence of the primary infection. Acute otitis media as a complication of one of the infectious fevers is the commonest form which results in chronic middle ear disease.

Treatment consists in (1) improving the general health and ensuring free drainage of the pharyngeal ends of the Eustachian tube by removing adenoids, etc., and keeping the nose and nasopharynx clear of all infectious secretions. (2) The middle ear must be kept free from any accumulation of discharge, and, if possible, mild antiseptics may be introduced to combat the infection. To cleanse the middle ear the Eustachian tubes should be inflated by Politzer's method or by Eustachian catheterisation, and the external meatus should then be syringed out with warm antiseptic lotion. The inflation and syringing is repeated and the ear carefully dried. Treatment as described for acute and subacute middle ear infection (p. 327) should also be persevered with for an extended period. For other methods of treatment of chronic middle ear suppuration text-books dealing specially with the subject should be consulted, as there is no doubt that in skilled hands and with patience a large number of cases can be cured without subjecting the patient to a serious operation.

It may be as well to emphasise here the fact that if purulent middle ear infection is treated efficiently in the acute stage there should be only a small decimal percentage of ears which are left permanently discharging and therefore septic (*i.e.*, a focus of chronic suppuration).

If, however, the mastoid antrum and process are extensively involved by the disease, or if any of the complications mentioned below are present, the discharge from the ear is not likely to cease until some further operative treatment is applied.

Complications of Chronic Otorrhœa. (1) Any chronic condition seen in the external auditory meatus may be secondary to middle ear infection, particularly chronic furunculosis and eczema.

(2) **Aural polypi** consist either of an inflammatory hypertrophy of the tympanic mucous membrane or are composed of granulation tissue. In the latter case they are not true polypi, but should be classed as granulomata. They usually arise singly, spring from the inner wall of the tympanum, grow through a large opening in the tympanic membrane, and may completely fill up the external meatus. The presence of a polypus generally means that the chronic middle ear infection is deep-seated and that the mastoid antrum is involved. It may give rise to bleeding from the ear.

Treatment consists in removal of the polypus with a snare, preferably under general anæsthesia, the application of a cautery to its base, and subsequently the application of the cleansing and general treatment described above for chronic otorrhœa. In a favourable case the discharge may cease and the infection clear up after this treatment.

(3) **Caries and necrosis of bone** underlying the aural mucous membrane or of the ossicles. Indication of this condition is afforded by excessive granulation tissue formation, offensive discharge and the fact that bare loose bone can be detected on probing. The only treatment is operative and is described under the treatment of chronic mastoiditis.

(4) **Chronic purulent inflammation of the mastoid antrum and cells.**

This condition occurs following an acute inflammation of the tympanum or the tympanum and mastoid antrum in a case in which free drainage is not established and the infection does not clear up. In other cases the primary infection may be so acute or drainage by means of opening the antrum is so long delayed that there is more or less extensive destruction of bone with the formation of sequestra. The whole of the mastoid process may be involved, the air cells in various directions into the temporal bone being infected, or the carious bone may be limited to that surrounding the antrum.

The symptoms complained of are deafness, chronic aural discharge, occasional attacks of pain in the affected ear due to congestion, tinnitus and vertigo, and sometimes tenderness on pressure over the mastoid process.

The diagnosis is made on the strength of the presence of the above symptoms, all of which are usually present at one time or another in the history of the case, and by the objective appearances. These consist of :—

(*a*) More or less constant copious discharge of considerable duration.

(*b*) Granulations and polypi which are liable to recur when removed.

(*c*) The presence of some œdema or thickening over the mastoid process.

(*d*) Irritation or transient paralysis of the facial nerve.

Treatment. When a protracted course of cleansing treatment to the ear has failed to cure the condition the only resource left is to lay open the mastoid process and middle ear and clear away all the diseased tissue.

The following are the main indications for opening the mastoid area and performing the so-called radical mastoid operation :—

1. Cases where caries of the tympanic wall exists.

2. Where recurring attacks of subacute mastoiditis have been noted.

3. When a mastoid fistula is present (post-auricular fistula).

4. Cases due to the bacillus tuberculosis.

5. Where there has been any paralysis of the facial nerve even if transient, the sooner the radical operation is performed the better will be the prognosis of preserving the function of the nerve.

6. Cases of protracted purulent and fœtid discharge resisting all conservative treatment are probably best dealt with by operation. The chronic septic focus eventually may give rise to trouble elsewhere, and there is always the possibility of intracranial complications at any time, even if there is no pain at all. In these cases the decision may be influenced by the amount of hearing present in the ear. If the opposite ear is healthy and normal the loss of hearing in the diseased ear, even if much increased by the operation, will not be so serious. (The hearing in cases of chronic otorrhœa varies from almost perfection to complete deafness, and the visible extent of the middle ear disease is no guide to the loss of function.)

7. **Cholesteatoma.** The exact pathology of this condition is disputed. It consists of a pultaceous mass of exfoliated dead squamous epithelial cells surrounded by a membrane of growing squamous epithelium. The growing epithelium arises either from mucous membrane which has undergone degeneration or from squamous epithelium which has extended through a perforation of the tympanic membrane and therefore originates from the skin lining the external auditory meatus.

Cholesteatomata rarely occur associated with the deep-seated nasal sinuses.

8. In all cases of suspected intracranial complication of a chronic otorrhœa the mastoid antrum and cells should be cleared as a first step in the operation.

The methods of operation now most frequently in use are on the lines of those first described by Schwartze and Stacke, and some form of combination and modification of the two produces good results.

The Radical Mastoid Operation. The position of the patient, anæsthetic, illumination and preparation of the skin are exactly the same as described on p. 329 for acute mastoiditis, and up to the opening and exposure of the mastoid antrum the technique is exactly similar. The posterior wall of the cartilaginous meatus is now separated from its bony bed, and the bridge of bone which separates the antral opening from the external meatus is cut away with a gouge. Whilst removing the deepest part of this bridge (*i.e.*, when laying the tympanum into direct external continuation with the antrum at the bottom of the operation field) great care must be taken not to injure the facial nerve. When the bridge has been removed completely, the cartilaginous meatus is divided longitudinally along its posterior wall into two flaps which are held forwards by retraction. The antrotympanic cavity is thoroughly cleared of ossicles, granulations and remnants of the tympanic membrane. The inner wall must be treated with respect when using the curette, the stapes should not be removed, and the commencement of the Eustachian tube only gently curetted owing to its proximity to the internal carotid artery. The mastoid process should be examined next and all the infected air cells cleared out, the tip of the process being amputated if necessary, and at the same time all infected cells extending backwards towards the occipital bone and upwards towards the posterior root of the zygoma are dealt with. When the cavity has been excavated so that it is lined with smooth healthy bone it is washed out twice with hydrogen peroxide (20 vols.) and warm saline. There are several methods of closing the wound. The flaps of the cartilaginous meatus are stitched back, so that their lining of skin will form a beginning for the growth of epithelium with which the cavity eventually becomes lined (Fig. 121). The whole cavity is then firmly packed with ½-inch gauze plugging impregnated with iodoform, the end of the plug presenting at the external meatus. The post-auricular wound is carefully sutured throughout its entire length. (For the methods of cutting the skin flaps from the external meatus a volume on aural surgery should be consulted.) The plug should, if possible, be left in situ for four days and then be removed. The cavity is cleansed with hydrogen peroxide syringing and repacked daily until a clean cavity is established. After about fourteen days it may be simply cleansed daily under observation, and any protuberant granulations cauterised until the whole cavity is lined with stratified epithelium and remains quite dry. Some surgeons line the entire cavity with a Thiersch skin graft before packing, and the advantage of this procedure is that the cavity becomes more quickly epithelialised and less post-operative packing is required.

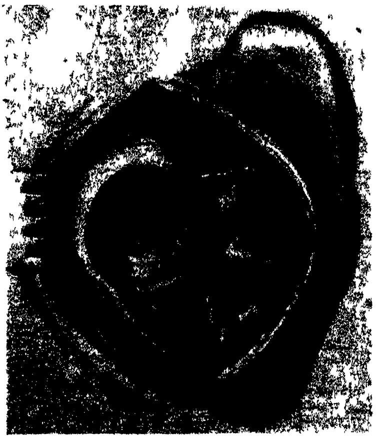

FIG. 121. The final stage in the radical operation for chronic mastoiditis. The meatal skin flap has been cut and sutured. The dura mater of the middle cranial fossa and that covering the lateral sinus has been exposed.

In the event of any intracranial complication being suspected before operation or found at the time, the operation field can be extended to enable this to be dealt with in exactly the same way as in the case of the intracranial complications of acute mastoiditis (see pp. 30–40).

As has been stated already, where chronic otorrhœa is present all intracranial infections should be approached by the mastoid route.

The intracranial complications of chronic middle ear suppuration are much the same as those of acute middle ear disease and are described in Ch. I., Vol. II.

Purulent Labyrinthitis. During the course of an acute or chronic suppurative otitis media the infection may spread to the internal ear or labyrinth. The infection usually gains access through the oval or round window, and it may then involve the entire membranous labyrinth or remain localised and circumscribed to some part of it. The symptoms of infection of the labyrinth are at first vertigo, nausea and vomiting, followed by increasing deafness. In the case of involvement of the whole internal ear deafness rapidly becomes complete. Pyrexia is marked, and there may be some inco-ordination of movements. Tinnitus is usually absent.

Treatment consists in performing the radical mastoid operation and then opening the labyrinth above and below the facial nerve canal to allow drainage.

Total deafness in the affected ear is the invariable result of this condition.

CHAPTER VIII

THE FAUCES, PHARYNX AND ŒSOPHAGUS

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Surgical Anatomy of the Fauces, Pharynx and Œsophagus. On opening the mouth widely and depressing the tongue, the *soft palate and uvula* are seen together with the *pillars of the fauces* and the *faucial tonsils*. The soft palate is level with the first cervical vertebra and the anterior pillars of the fauces spring from its anterior surface and arch forwards and downwards to the posterior extremity of the lateral border of the tongue. The anterior faucial pillars are formed by a fold of mucous membrane containing the palatoglossus muscle. The posterior pillars of the fauces are two folds of mucous membrane containing the palatopharyngeus muscle which spring from the lower free border of the soft palate. Running down behind the tonsils, they are lost upon the posterolateral wall of the pharynx. The muscles of the pillars of the fauces act as constrictors of the faucial isthmus.

The *faucial tonsils* completely occupy the space between the pillars of the fauces except that superiorly a small recess is left, known as the supratonsillar fossa.

Each tonsil is covered on its free surface by mucous membrane, on which are seen the orifices of the tonsillar crypts, the crypts being lined with epithelium continuous with that on the surface of the tonsil. The outer or deep surface of the tonsil is covered by a layer of fibrous tissue which forms an imperfect capsule to the organ. It is this capsule which is of such importance in the operation of enucleating the tonsil, as it can be separated readily from the muscular wall of the pharynx (superior constrictor), and the tonsil completely removed.

The internal carotid artery lies about 1·5 cm. behind the outer margin of the tonsil as well as being external to the superior constrictor muscle. It is not, therefore, in any danger during the operation of tonsillectomy. The tonsil receives its blood supply from branches of the ascending palatine, ascending pharyngeal, facial and dorsalis linguæ arteries, and the larger branches usually enter the upper lobe of the organ.

When the tonsil becomes hypertrophied in children or adolescents the enlargement may be general, and marked towards the middle line (causing the tonsils to show up very prominently on examination), downwards along the pharynx, or imbedded deeply between the pillars of the fauces and extending upwards behind the soft palate. The last-mentioned varieties can be removed quite easily by dissecting the tonsil free just outside the plane of the capsule.

The mucous membrane of *the pharynx* below the soft palate is covered with a squamous epithelium which is continuous with that of the œsophagus.

The *lymphatics* of the nasal fossæ, nasopharynx and fauces, including the soft palate and faucial tonsils, drain into the subparotid and upper deep cervical glands in the region of the angle of the mandible. The glands can be seen and felt to be enlarged in chronic infections of these regions.

In children suppuration arising in one of these glands is the commonest cause of retropharyngeal abscess.

In the adult the upper four cervical vertebræ may be explored digitally from the mouth, while in the child the finger can reach down as far as the sixth cervical vertebra and the back of the cricoid cartilage.

The *œsophagus* commences at the lower border of the cricoid cartilage opposite the sixth cervical vertebra, *i.e.*, 6 inches in a straight line from the incisor teeth. Its average length is 10 inches, but it varies considerably (8 to 13 inches). The left bronchus crosses it about 9 inches (25 cm.) from the teeth, and the œsophageal opening of the diaphragm is 15 inches (39 cm.) from the teeth, the cardiac orifice of the stomach being at about 16 inches. The cervical portion is always closed and flattened from before backwards except during deglutition.

There are two distinct constrictions of the œsophagus, one at its commencement and the other at the point where it is crossed by the left bronchus. Both constrictions are the same size and will admit a tube 20 mm. in diameter quite easily. The rest of the œsophagus is 3 or 4 mm. wider in diameter.

The cardiac orifice of the stomach is at the level of the tenth dorsal vertebra. The muscular wall of the first third of the œsophagus is composed entirely of striated muscle fibres, but the passage of a bolus of food down the œsophagus is quite involuntary.

The longitudinal muscle fibres of the œsophagus at its upper end separate into two bands, which pass forwards round the tube, to become attached to the back of the cricoid cartilage. In some persons an area is therefore left below the border of the inferior constrictor muscle of the pharynx which is only weakly supported by muscle fibres, and it is from this point that a pressure diverticulum of the pharynx may develop (the so-called œsophageal pouch).

Although these muscular layers are mentioned in detail it should be remembered that the œsophagus is a very thin-walled structure. It is lined throughout with thick stratified epithelium, and the mucous membrane contains mucous glands.

The *lymphatics* of the upper end of the œsophagus open into the lower cervical glands, the remainder into the posterior mediastinal glands.

AFFECTIONS OF THE TONSILS AND PILLARS OF THE FAUCES

A **foreign body** may become lodged in the faucial region, in which case it is usually a small sharp-pointed object such as a small bone, pin or piece of wire, which gets impacted in or pierces the mucous membrane during the act of deglutition. The patient complains of something constantly pricking the throat, and this may be severe enough to cause nausea and vomiting. The object can be seen with a good light or felt with the finger quite easily.

Treatment. The mouth and pharynx should be examined by means of frontal illumination and the use of a spatula, and if necessary by digital examination also. Fine bones or pieces of wire are often difficult to see, especially if imbedded in the tonsil, as only a small part may be showing relative to the amount buried in the tissue. All foreign bodies must be removed at once with suitable forceps.

Vincent's Angina is a form of stomatitis or pharyngitis due to the presence of the B. fusiformis and a certain type of spirochæte. The causative organisms are often present in the healthy mouth and are awakened into activity by local irritation, or by the general resistance being lowered owing to debility. It is characterised by the development of ulcers on the gums, faucial pillars, tonsils or posterior wall of the pharynx; the ulcers may appear almost clean or they may be covered by a sticky, fibrinous, yellow pseudomembrane, which is adherent, and the removal of which causes bleeding. Pain is always present, and this may be severe on swallowing. In the more acute cases there is a certain amount of pyrexia, the patient feels ill, and the cervical glands are slightly enlarged and tender. The smell is often characteristic.

Diagnosis. The condition has to be differentiated from diphtheria, tonsillitis or syphilitic ulceration, and in order to verify the diagnosis a swab always should be taken and the direct smear examined under a microscope for the presence of the specific organisms.

Treatment. The ulceration reacts well to the local application of strong antiseptics, of which painting the ulcers with tincture of iodine three times a day is the most satisfactory. At the same time the mouth must be kept as clean as possible by the use of mouth washes and gargles, and the general condition treated. Intravenous injections of arsenic (salvarsan) may be given. The patient should be removed from any unhealthy surroundings and encouraged to eat plenty of nourishing food.

Tuberculous ulceration may occur in the form of lupus spreading from the nose or cheeks. Lupoid ulcers are slightly granular and shallow, cause no pain and show no tendency to invade the deeper tissues. Curetting, cauterising with pure lactic acid or the application of X-rays have been utilised for this disease. Diathermy cauterisation under general or local anæsthesia is a successful method of eradicating the local tuberculous disease of a lupoid nature, but may cause scarring and stenosis.

Apart from lupus, various forms of tuberculous ulceration may attack the tonsils and buccal mucous membrane, but they are nearly always secondary to pulmonary tuberculosis. They may be similar in appearance to the indolent tuberculous ulcers which sometimes appear on the tongue, but in cases where the general infection with the B. tuberculosis is extensive there may be diffuse ulceration of the buccal mucous membrane accompanied by pain and swelling sufficient to cause marked dysphagia. Such cases do not survive more than a few weeks, and tubercle bacilli generally can be found in the sputum in large numbers.

Syphilis. (*a*) *Primary chancre* is rare, but cases are occasionally seen in which the tonsil is affected. In these patients the secondary manifestations appear early and the course of the disease is severe.

(*b*) In *the secondary stage* of syphilis the so-called " snail track " ulcers or " mucous patches " are usually seen on the soft palate, cheeks and tonsils. They are not true ulcers, but consist of patches of sodden undesquamated mucous membrane, and it is only when the epithelium is shed that ulceration is present. The grey, shiny appearance of these " ulcers " is characteristic, and the Wassermann test reaction will settle the diagnosis.

(*c*) *Tertiary syphilitic ulcers* are the result of breaking down gummata and are relatively common. They are often very extensive and are characterised by the irregularity of their outline and the depth and extent of the normal tissue destroyed. Where the pharyngeal wall is affected, after healing has occurred, the soft palate may become adherent posteriorly and scarring with great deformity may be produced, leading to difficulty in deglutition and regurgitation of fluids into the nose.

The *diagnosis* is made on the character of the ulcers, which are punched out, multiple, not indurated, with a yellow slough, giving rise to no pain and causing very little secondary glandular enlargement or constitutional disturbance.

General antisyphilitic treatment must be energetic (Vol. I., Ch. VI.), and plastic operations may be required subsequently for the resultant scarring.

Extensive scarring of the fauces due to healed ulceration is sometimes seen as the result of other diseases than syphilis, namely, from severe cases of diphtheria and scarlet fever, but the destruction of deep tissues and resultant deformity is never very marked.

Acute tonsillitis is the result of coryza, a chill or the inhalation of impure or infected air or sewer gas. It is often seen among residents in hospitals or institutions in which the patient is in contact constantly with infected air, and it may occur among the residents in a house in which there is some defect in the drainage allowing the escape of foul gas. When dealing with any acute infective throat condition the possibility of it being diphtheria (or one of the acute exanthemata) *always* must be considered and excluded. Three conditions are usually described :—

(*a*) **Acute Superficial Tonsillitis.** This is nothing more than a slight superficial inflammation of the mucous membrane covering the tonsil, which has extended from a general inflammation of the nasal and pharyngeal mucous membrane as the result of a cold. The mucous membrane becomes red and painful but there is very little swelling, and once the early or congested stage of the cold has passed off the pain and inflammation tend to subside. Anticatarrhal remedies are indicated, such as douching the nose with bland lotion and cleansing the throat. The pain is usually relieved by the use of an astringent gargle or spray, such as chlorate of potash, but stronger solutions of zinc sulphate and alum may be tried with advantage.

(*b*) **Acute Follicular Tonsillitis.** This condition is characterised by a general enlargement of the tonsil, which appears swollen and is dusky red. There is severe pain on swallowing and the swelling may be large enough to threaten obstruction to respiration. There is a varying amount of yellow discharge from the follicles, and sometimes this is sufficient to coagulate on the surface, giving rise to the appearance of a false membrane, distinguished from that of diphtheria by its lack of adhesion to the subjacent tissue, and by the absence of the Klebs-Loeffler bacillus on microscopical examination. The hæmolytic streptococcus is the usual causative organism. The temperature is high, there are much malaise, headache and general aches and pains, while there is usually tenderness on pressure on the enlarged cervical glands below the angle of the jaw. Patients suffering from chronic enlargement and infection of the tonsils are rendered more liable to attacks of acute follicular tonsillitis, and a history of two or three attacks may be taken as an indication for removal of the tonsils.

Treatment. As regards immediate treatment, a brisk purge should be administered and an antipyretic, such as aspirin or salicylate of soda, or a mixture of perchloride of iron (Tr. ♏xxv), and sulphate of magnesia (grs. x) may be given four-hourly. Locally astringent gargles may be applied as for superficial tonsillitis, and the patient may get considerable relief by the inhalation of steam from hot water (150° F.), to which a few drops of creosote or compound tincture of benzoin (Friar's balsam) have been added. In more severe cases, and when toxæmia is marked, 10 or 20 c.c. of concentrated antistreptococcal serum may be given by intramuscular injection. M. and B. is often very helpful.

FIG. 122. Peritonsillar abscess.

(*c*) **Acute suppurative tonsillitis (peritonsillar abscess or quinsy)** is an acute inflammation of the tonsil with suppuration round it, the pus remaining within the capsule. Both tonsils are in addition affected and inflamed, but the suppuration may occur in one tonsil only, or if it occurs in both, one is affected before the other and the abscess may be incised or burst on one side, to be followed by a similar abscess forming on the opposite side. All the symptoms of acute follicular tonsillitis are present in an aggravated form and the swelling is more marked.

Diagnosis. Acute follicular tonsillitis has to be distinguished from the specific fevers which start with an inflammation of the buccal and faucial mucous membrane. The most important are scarlet fever and diphtheria. Scarlet fever can be diagnosed by the characteristic skin rash and appearance of the tongue and the history of contact with a similar case, diphtheria by the appearance of the characteristic membrane and the presence of the Klebs-Loeffler bacillus on cultivation from a throat swab. Bacteriological examination always should be carried out in doubtful cases. The presence of enlarged and tender cervical glands is more suggestive of tonsillitis, while the temperature and malaise are usually more marked in this latter condition.

The diagnosis of peritonsillar abscess has to be made from acute follicular tonsillitis without abscess formation and from an inflamed tonsil, which is also the seat of malignant disease, such as sarcoma. It also has to be distinguished from all the other septic and specific ulcerations of the fauces.

When pus is present round the tonsil, the latter becomes displaced towards the midline, and there is a definite fulness of the anterior pillar of the fauces and fluctuation may be detected. A peculiar purple or dusky bulging swelling usually appears above the tonsil when pus has formed.

Treatment. The treatment of peritonsillar abscess medicinally and generally is similar to that for acute tonsillitis without pus formation. Once fluctuation is detected or there is sufficient indication that pus is definitely localised, the condition must be dealt with by incision and evacuation of the pus. The mouth is held open as widely as possible—this may not be very wide owing to pain caused by the inflamed part—and an incision is made at the level of a line drawn from the last upper molar to the base of the uvula, and nearer the inner than the outer end of the line. The cut is made in a direction from without inwards to a depth of about a quarter of an inch, and may be made with a knife blade guarded except for its last half inch. This operation may be easier if the throat is first sprayed or swabbed with 10 per cent. cocaine solution. There is no need to make a deep incision, as once the mucous membrane has been divided, the enlarging of the opening should be completed by pushing the closed blades of sinus forceps or artery forceps through the incision outwards and upwards until pus is encountered. The blades of the forceps are then opened and as wide a track as possible is opened up. The whole of this operation must be carried out as rapidly as possible, owing to the pain and discomfort it causes the patient. As soon as the pus has escaped into the mouth the patient should spit it out and wash the mouth out thoroughly for some minutes with hot boric lotion. The relief experienced on evacuation of the pus is very marked, and if the opening tends to close up too soon it will be necessary to dilate it by means of sinus forceps in the same way as following the incision. Hot fomentations should be applied to the neck externally. Owing to the debilitated condition of these patients, tonics should be administered during convalescence.

Chronic tonsillitis occurs in two distinct forms :—

(*a*) **Simple hypertrophic tonsillitis** is much more common in children than in adults, and is almost always accompanied by the presence of masses of adenoids. It may be the result of one or more acute attacks of tonsillitis, but there may be nothing definite in the history to account for the enlargement. The hypertrophy is certainly more common in cold and damp climates, in which the children are confined indoors for a large part of their time. The children are usually weakly and the condition occurs at any age, but is most common and marked about the sixth to the eighth year. The tonsils are enlarged, pale and firm in consistence, and the openings of the crypts and follicles may be seen gaping on the surface, sometimes plugged with mucus. The more chronic the enlargement the more fibrosed does the hypertrophied tonsil become. The collection of purulent débris is often seen to lie beneath a layer of mucous membrane and it then has the appearance of a yellow cyst Occasionally concretions known as *tonsilloliths* are formed, of which the basis is lime salts. The hypertrophy in some children is so marked that the tonsils meet in the middle line and cause partial obstruction to swallowing and respiration, but in others they do not project inwards so much, lying buried deeply between the faucial pillars. In the latter case the enlargement can be recognised only by pressing inwards from the neck and causing the patient to gag or strain with his throat. Owing chiefly to the accompanying nasopharyngeal obstruction, due to the adenoids, the patient breathes with the mouth open, and this is specially noticeable during sleep; hearing is often interfered with for the same reason, as the Eustachian tubes become thickened and inflamed. If there is any infection present in the tonsil the cervical glands near the angle of the lower jaw may be chronically enlarged, and during or subsequent to an attack of acute inflammation this enlargement is more marked.

(*b*) **Chronic inflammatory tonsillitis** is a condition in which the tonsil is the seat of chronic septic infection which may be exacerbated at times by acute inflammation, but which in other cases lies dormant and unsuspected for years. It may occur in a normal-sized tonsil and also it may accompany the chronic hypertrophied tonsil above described. In some chronic cases the tonsillar lymphoid tissue becomes atrophied and fibrosed, and the tonsil shrinks back but retains the septic infection permanently in the fibrous follicles. The infection of the tonsil is frequently accompanied by enlargement of the cervical glands on one or both sides, and at times when the infection becomes acute the cervical glands may be acutely inflamed and even suppurate. On inspection of the infected tonsil yellow spots are to be seen on the buccal surface, and these can be removed by rubbing the tonsillar surface with a swab. The presence of purulent spots on enlarged or fibrosed tonsils is almost pathognomonic of the presence of a chronic infection. The condition known as *keratosis pharyngis* always must be borne in mind when making a diagnosis (vide p. 348).

In order to make sure that the purulent débris is coming actually from the depths of the tonsil, pressure may be applied to the anterior pillar by means of a metal probe wrapped firmly round with cotton wool. As the tonsil is forced backwards and the patient strains, the cheesy-looking purulent débris is seen to be extruded from the follicles. It is important to remember that chronic tonsillitis may be the cause of many other more general affections or the source of an infection which may be blood-borne to various other organs of the body. In children it is commonly found to be the portal of infection for such conditions as acute nephritis, rheumatism and cardiac infections. Tubercle bacilli frequently have been demonstrated to be present in the tonsil in large numbers, and in nearly all cases of tuberculous cervical adenitis the nidus of infection is the tonsil.

In all cases of cervical adenitis, no matter how severe the existing inflammation, it is advisable to remove the tonsil prior to performing an external operation for excision of the enlarged glands.

In adults a diseased tonsil may be the primary source of infection of any condition which is recognised as being due to the staphylococcal or streptococcal organisms or their toxins (and this possibility has been mentioned in the diagnosis of the various diseases concerned). When a patient suffering from chronic follicular tonsillitis actually complains of any throat symptoms these are usually referred to as vague soreness of the throat, worse at times, but often absent altogether for prolonged periods. The condition is then detected only during a routine examination by the surgeon.

Treatment. Once the diagnosis of definitely hypertrophied or chronically infected tonsils has been made, much the most satisfactory treatment is removal of the tonsils by operation. In children, especially under the age of four, general treatment may be tried first, such as the administration of tonics and removal of the patient to fresh or seaside air. The results observed from the removal of hypertrophied or infected tonsils are, however, so satisfactory that it is not worth while delaying the operation long if the child does not speedily react to general treatment. The operation of tonsillectomy, complete removal of the organ, always should be performed.

Tonsillectomy. As has already been mentioned on p. 305, this operation is in children nearly always combined with that for removal of the adenoids. Therefore, the operation for the two conditions combined in a child will be described first.

A great variety of methods of enucleating the tonsils have been devised and described for the treatment of this very common affection, but it is only proposed here to detail one useful and very commonly favoured method.

For many years the guillotine method has been losing popularity in this country, and it should now be employed only by experts who for reasons of their own prefer this type of operation.

The important features of the operation are:—

1. To remove the tonsils and adenoids completely and leave no tags of adenoid tissue in the nasopharynx or tonsillar tissue attached to the pharyngeal wall or the base of the tongue.
2. To produce as little shock as possible to the patient.
3. The operation should be carried out without doing any damage to the faucial pillars or the soft palate.
4. Care must be taken that no blood enters the trachea.
5. As far as possible all danger of post-operative hæmorrhage must be eliminated at the time of the operation by the surgeon satisfying himself that there is no definite bleeding point at the time the patient leaves the operating table.

The surgeon must be provided with a suitable head light.

The child is anæsthetised in the dorsal recumbent position, and when well relaxed a pillow is placed beneath the shoulders sufficient to raise them from 2 to 4 inches above the level of the flat operating table. The amount of elevation of the shoulders varies according to the preference of the surgeon, but there should be no pillow beneath the head, and the more the head is allowed to hang back extended from the shoulders the less danger is there of blood entering the trachea at the time of operation. Before starting the operation the pharyngeal reflex should be abolished, and there is no objection to the anæsthesia being pushed to sufficient depth to abolish the laryngeal cough reflex, as if reasonable care is taken there is no danger of blood reaching the larynx.

A gag of the Davis type (see Fig. 125) is introduced into the mouth and opened. This gag is provided with a tooth plate A and tongue elevators B of various sizes to suit children or adults of different age and dentition, and when it is properly adjusted and in position an excellent view of the fauces and mid-pharynx is obtained (see Fig. 126).

The continuance of the administration of the vapour of the anæsthetic may be maintained by means of a metal tube attached to or incorporated in the blade of the tongue elevator.

The adenoids or the tonsils can now be removed under direct observation and with whatever degree of deliberation the surgeon wishes. Any blood which escapes from the divided tissues tends to run down into the nasopharynx, and if it collects in the mouth and mid-pharynx it can be removed readily by gauze mops or by means of a suction tube passed through the nose into the nasopharynx.

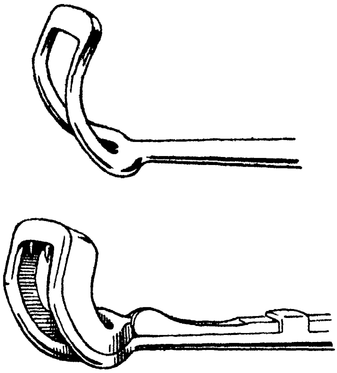


FIG. 123. Adenoid curette.

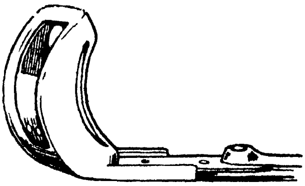


FIG. 124. Adenotome, showing cutting blade.

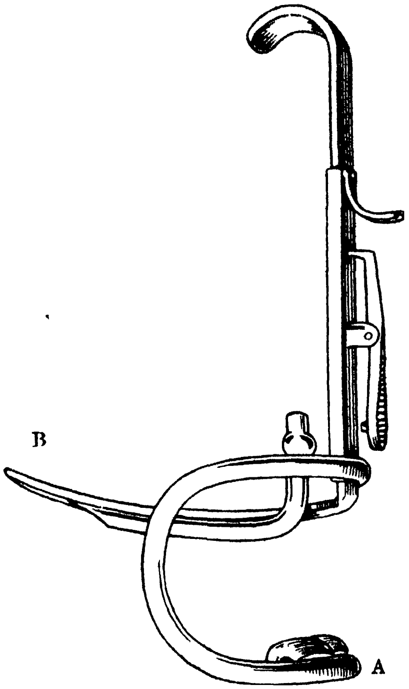


FIG. 125. Davis Gag.

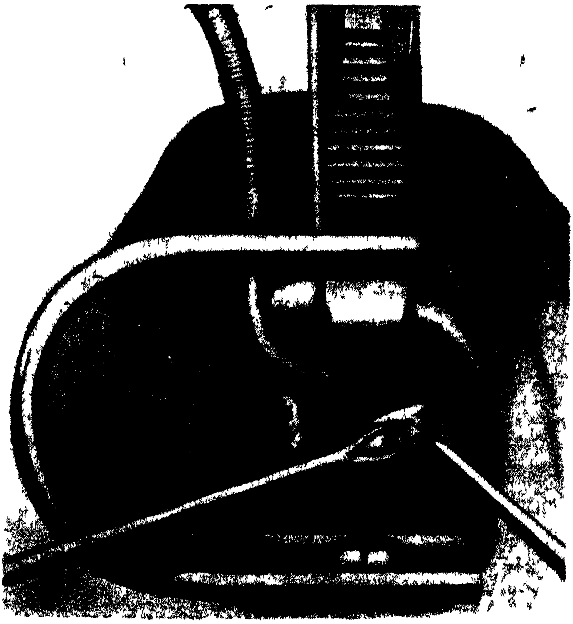


FIG. 126. Davis Gag in position. The right tonsil is partially dissected away.

It is usual to remove the tonsils first, but there are advantages to be gained by dealing with the adenoids before proceeding to the enucleation of the tonsil.

1. There is less danger of injuring the soft palate during the adenoid clearance and subsequent digital examination of the nasopharynx if the tonsils are still in position and adding by their presence to the toughness of the faucial pillars.

2. If the tonsils are removed after the adenoids, the nasopharynx may be packed with gauze following the adenoidectomy and the gauze left in position until the tonsil operation and hæmostasis is complete. The nasopharyngeal plug is then removed and there should be no further bleeding from this raw surface. The patient can be at once removed to a bed, and in addition the amount of blood lost as a result of the adenoid operation is diminished.

The adenoids are usually cut or curetted out by means of a special adenoid curette (see Fig. 123). The adenoid curette is passed behind the soft palate under direct observation, and the blade of the curette is pushed downwards (the head of the patient being of course inverted) to the roof of the nasopharynx and firmly engaged between the adenoid growth and the posterior free edge of the nasal septum. Firm pressure is now applied and the blade of the curette moved sharply backwards and upwards along the postero-superior nasopharyngeal wall and keeping to the midline. If this manœuvre is correctly carried out and the adenoid curette is of the size which fits accurately the nasopharynx, the whole mass of adenoid tissue is cut away from its bony recess in the one sweep. The nasopharynx should be examined digitally and any residual tags of lymphoid tissue cut out with a smaller bladed instrument. Care must be taken not to apply the curette to the region of the Eustachian tubes.

Some surgeons prefer to cut the adenoids out by means of an adenotome (Fig. 124).

As soon as the operation is satisfactorily completed a gauze plug is packed into the nasopharynx to arrest the hæmorrhage and the tonsil operation is commenced.

By means of a pair of special ring forceps held in the left hand the patient's right tonsil is seized and pulled out of its bed between the faucial pillars towards the midline.

The mucous membrane covering the sharp margin of the anterior faucial pillar is thus put slightly on the stretch and the edge of the pillar is partly obliterated. At about the middle of the margin of the anterior pillar the mucous membrane is divided and separated vertically until the capsule of the tonsil is readily identified. With scissors or a blunt dissector the membrane is divided round the faucial arch and backwards along the posterior pillar (Fig. 126). The tonsil is now dissected completely away from the constrictor muscle of the pharynx by means of a blunt dissector, the forceps holding the tonsil being moved to take a fresh grip as the operation progresses.

At the end of this dissection the tonsil will be attached to the pharyngeal wall only by the mucous membrane reflected from the surface of it on to the side of the base of the tongue. Lymphoid tissue is frequently prominent in this region (*Lingual tonsil*), and if it is present it is more difficult to separate from the pharyngeal muscle and the muscles of the tongue than is the faucial tonsil.

This is due to the fact that muscle fibres run into the areolar tissue supporting the lingual tonsil. It will be necessary therefore to finish off the removal of the tonsil, by means of a snare or by passing a pair of crushing forceps astride the pedicle and tearing off the lymphoid mass.

Hæmorrhage is dealt with according to its amount as the operation progresses, the important factor in this connection being that the operator must see that the blood does not collect in the inverted nasopharynx and roof of the mouth to such an extent that it threatens to overrun in the direction of the larynx.

At the end of the operation the surgeon satisfies himself that there is no bleeding point, but if any is seen it is picked up and ligatured.

The gauze plug in the nasopharynx is now removed, and it should be found that all bleeding from the adenoid wound has ceased. The patient may then be removed to bed, and should lie on his side with the head low so that any saliva or exudate from the wounds can run out of the mouth.

NEW GROWTHS OF THE TONSILS, PILLARS OF THE FAUCES AND SOFT PALATE

Non-malignant growths are very uncommon. Occasionally *lipomata* and *fibromata* are found beneath the mucous membrane, and usually they can be easily shelled out. *Papillomata* are not so uncommon, and usually appear as a flat whitish layer of thickened epithelium spreading over the normal pink mucous membrane. A papilloma can be removed by excision, or by means of the diathermy cautery, but if a recurrence of the growth appears more than once there is always the possibility that an epithelioma may start from the locality, and this contingency must be watched for.

By far the greatest number of pharyngeal new growths are malignant, and carcinomata are much more common than sarcomata.

Sarcoma of the tonsil may occur at any age. Lymphosarcoma is the most common variety. The tonsil is found enlarged, darkish red in colour, smooth in outline and firm in consistency. It is mobile at first, but soon becomes fixed, and even before fixation has occurred by local extension there is secondary enlargement of the cervical lymphatic glands. The diagnosis is made from simple hypertrophy by the rapid growth, excessive enlargement and infiltration.

Signs. There may be some pain on swallowing and some obstruction to respiration, but usually the patient consults the surgeon on account of the mass of glands noticed in the neck.

Treatment. Where feasible the tonsil should be removed together with the mass of lymphatic glands. This type of sarcoma has been found to react favourably to radiotherapy and its application is always worth a trial. If an operation is carried out for the application of radium needles the latter should be applied wherever there is evidence of the growth having spread, particularly along the lines of the lymphatic drainage. Small needles containing from ½ to 5 mg. of the active element should be dotted about so that if possible the whole of the infected area may come within range of the active rays. The needles may be left in for a week or ten days and the dosage must be estimated in millicurie hours.

Carcinoma of the Tonsil. This is of the squamous-celled type and may start on the surface of the tonsil, but more commonly spreads on to it from the anterior pillar, soft palate, base of tongue or lateral pharyngeal wall. Wherever the growth starts it tends to spread in any direction, but particularly downwards along the lateral wall of the pharynx and upwards on to the soft palate. The deep cervical lymphatic glands are involved early, and assume the appearance of typical carcinomatous glands (see Vol. I., Ch. VIII.).

Diagnosis. The appearance of a well-developed growth is quite characteristic, a deep sloughing ulcer being formed with indurated everted edges fixed to the surrounding tissues, while on palpation the ulcer feels hard and craggy. Pain on swallowing often occurs quite early, but it may be absent altogether, and the condition is frequently taken for an ordinary sore throat by the patient, who may not consult a doctor for some time. As the growth progresses, swallowing, respiration, and speech become more difficult, and the jaw becomes partially fixed, as also does the tongue. The condition has to be differentiated from tuberculosis and syphilitic ulceration.

Treatment. An epithelioma of this region if diagnosed early presents a favourable chance of cure by excision. The operation should be undertaken both from the mouth and neck, either separately or at the same time. The faucial part of the operation should be done first and the growth freely excised, if necessary at the expense of part of the soft palate and the base of the tongue. The diathermy cautery knife is a very useful instrument for attacking a malignant growth in this region owing to the fact that there is no bleeding when it is used and there is no necessity for very accurate dissection. It is, however, useless to do the buccal operation without removing the enlarged deep cervical and submaxillary lymphatic glands, and this is carried out through an incision parallel to the anterior border of the sterno-mastoid, the glands being thoroughly cleared down to the pharyngeal wall. The glandular operation is the same as that for removal of the glands in carcinoma of the tongue (see p. 208).

If the growth is too extensive for removal by the above operation it may be removed by the operation of lateral pharyngotomy, the cervical glands being cleared in this case before the pharynx is opened (vide p. 350).

Many cases are found to be too advanced for surgical removal, and then radium may be tried. The results of both operative and ray treatment for cancer in this region are disappointing except in cases diagnosed at a very early stage.

AFFECTIONS OF THE PHARYNX

(Not including the nasopharynx, see Ch. VII.)

Examination. The oropharynx can be inspected by means of frontal illumination and a spatula, but the lower pharynx can be satisfactorily seen only by means of the laryngoscope and the nasopharynx by posterior rhinoscopy. By means of the laryngoscope the walls of the pharynx can be examined down to the level of the upper border of the cricoid cartilage. A still more thorough examination can be carried out under anæsthesia by means of the direct laryngoscope.

Foreign Bodies in the Pharynx. A variety of foreign bodies have been met with in the pharynx. Large objects become impacted at the entrance to the œsophagus, and if of sufficient size may at the same time obstruct the entrance to the larynx. If the symptoms are urgent they should be dealt with at once by digital examination, and if possible dislodgment of the mass. Small, sharp objects, such as pins or fish bones, may pierce the mucous membrane at any point, but most commonly they lodge in the tonsil or posterior surface of the tongue, as has already been stated. They may be detected by direct examination, indirect laryngoscopy or digital examination and removed by suitable forceps.

INFLAMMATORY DISEASES

Acute pharyngitis is generally the result of the extension of infection from the nasal mucous membrane or the fauces, and results from exposure to cold or infected air and from the general exanthematous infections such as measles, scarlet fever and diphtheria. It is characterised by redness and swelling of the mucous membrane, which becomes covered with adherent mucus or mucopus. There is great pain on swallowing, and an irritable cough usually develops. This condition is frequently associated with acute infective tonsillitis and the general toxæmia may be very severe, especially when the organism producing the inflammation (found by bacteriological examination of a throat swab) is the hæmolytic streptococcus. Ulceration may follow similar to that seen in the mouth and fauces. In children especially, the surgeon should be on guard against acute pharyngitis being an early symptom of one of the exanthemata.

The *treatment* consists in attending to the general condition, and administering antipyretics and purgatives. Sucking ice sometimes relieves the pain and an astringent gargle always will be found soothing. Steam inhalations of Friar's balsam or creosote often give great relief. When the infection is severe and hæmolytic streptococci are found treatment must be energetic. Strong antiseptic mouth washes are indicated, anti-streptococcal serum and sulphanilamide should be administered, and particular attention must be directed to seeing that the airway does not get obstructed and that cervical suppuration does not pass unnoticed. The mouth and upper air passages should be examined later for the existence of chronic infection in cases where more than one attack of acute inflammation has occurred, and if found this should be dealt with.

Chronic pharyngitis consists of a chronic hyperplastic inflammation of the mucous membrane of the pharynx. It may be the sequel to successive acute attacks, or it may come on gradually in people who lead sedentary lives in an unhealthy atmosphere. Frequently no apparent cause for its onset can be discovered. It is more common in adults than in children, and more common in men than in women, and this is probably due to freer indulgence in smoking, drinking and eating. Among the commoner local conditions which give rise to chronic pharyngitis may be mentioned infected tonsils, nasal obstruction causing mouth breathing, chronic infection of any of the accessory nasal air cavities, and septic teeth. The surgeon, therefore, must eliminate the possible presence of any of these conditions before proceeding further with the treatment of the pharyngitis itself. The gouty, rheumatic, and syphilitic diatheses predispose to the disease, which is also commonly met with in anæmic or dyspeptic and constipated people.

Various names are applied to the condition of chronic pharyngitis, such as simple chronic pharyngitis, hypertrophic pharyngitis, granular pharyngitis, pharyngitis sicca, and atrophic pharyngitis, but from a pathological standpoint these varieties represent different phases of the same disease.

A feeling of discomfort in the throat is the common complaint, and owing to the tenacious secretion " hawking " is necessary to dislodge the mucus. These symptoms are usually more marked on rising in the morning or after prolonged use of the voice. Weakness of the voice is a common symptom which finally induces the patient to seek medical advice.

On examination of the pharyngeal mucous membrane by the naked eye, changes may be so slight as to escape detection. In other cases, there is marked congestion of the mucous membrane of the pharynx and fauces, the patient is intolerant to examination and retching is induced easily. There may be irregularity of the surface of the mucous membrane in the shape of small round nodules, often no larger than a pin's head, patches of discoloration and ridges of hypertrophied lymphoid tissue. The surface may appear excessively moist, and even covered with a layer of frothy mucus, or it may be dry and glazed with crusts of dried secretion adherent to it.

Pathologically there is hypertrophy of the small submucous blood vessels, fibrous tissue and patches of lymphoid tissue, intermixed with areas where the reverse is the case, and atrophy of all three tissues may predominate according to the stage which the local disease has reached. The local condition should be recognised easily, but it is often difficult to discover the underlying constitutional cause or to appraise its influence at its true value.

Treatment. Any pathological conditions of the nose or mouth call for preliminary attention and treatment. A warm alkaline lotion should be used night and morning as a douche to the nose and gargle to the throat. Equal quantities of sodium chloride, sodium bicarbonate and sodium biborate are made into a powder; about half a teaspoonful of the mixture to six ounces of water makes a very satisfactory wash for the nose or throat. This alkaline lotion can be used as a bland douche for any form of nasal infection. Diseased tonsils are liable to be overlooked when searching for a local cause. In cases of the moist hypertrophic type of pharyngitis the application of astringents by means of a camel hair brush is beneficial. Mandl's paint or a similar solution, such as pot. iod. grs. xv, iodine grs. ij, distilled water to 1 ounce, may be applied every other day to the soft palate, fauces and pharyngeal mucous membrane. Silver nitrate 5—10 per cent. or zinc sulphate 2—5 grs. to the ounce, are useful astringents. Astringent pastilles should be used with caution, as if the condition is due to derangement of gastric function they will aggravate the condition. In rare cases it may be advisable to cut off the end of an elongated uvula under local anæsthesia, a solution of 10 per cent. cocaine being adequate for this purpose. The granules or lymphoid hypertrophies on the posterior wall may be destroyed by the actual cautery under local anæsthesia.

Keratosis pharyngis is an uncommon affection of the pharynx, which is mentioned here owing to the necessity of distinguishing it from chronic follicular tonsillitis. It usually occurs between the ages of fifteen and forty, and is characterised by the appearance of small isolated tough and firmly adherent excrescences on the healthy mucous membrane. The excrescences are most commonly found on the tonsil, but by means of the laryngeal mirror they also may be seen on the base of the tongue. Their presence in the latter situation and the fact that they can be separated from the mucous membrane only with difficulty at once settles the diagnosis from chronic follicular tonsillitis. The condition does not give rise to any symptoms, and patients usually present themselves for treatment on account of having noticed the white spots at the back of the throat. If removed the excrescences invariably recur, but tend to disappear in time without treatment.

SPECIFIC INFECTIVE DISEASES OF THE PHARYNX

(1) **Syphilis.** The *primary and secondary* manifestations of syphilis in the pharynx are similar to those described in relation to the fauces. *In the tertiary stage* diffuse gummatous infiltration is met with, which if untreated breaks down to ulceration followed by extensive scarring. Antisyphilitic treatment produces very favourable results with these cases, and should be commenced at once and to the fullest extent. If the ulceration is severe, marked contraction of the pharyngeal walls may result due to scarring, causing obstruction to respiration and deglutition. This state of affairs is rarely seen nowadays. Localised gummata may form in the posterior wall or behind it, and these must be carefully differentiated from enlarged deep cervical glands due to tuberculosis or chronic septic infection. In children a breaking down gland may cause a large swelling to project the mucous membrane forwards into the pharynx.

(2) **Tuberculosis of the pharynx** is rare and occurs only as a secondary infection from the lungs or larynx, or as an extension of the local laryngeal disease. When the disease appears in the pharynx its progress is rapid, there is considerable infiltration, swelling and ulceration, and pain is marked. In cases of acute general tuberculosis superficial ulceration of the pharyngeal mucous membrane may be seen similar to that observed in the mouth and fauces. Pain may be so severe as to cause great difficulty in swallowing, and the most satisfactory method of combating this is the administration of insufflations of orthoform and anæsthesin powder (2½ grs. of each), by means of an insufflation tube, about twenty minutes before the meal is taken.

(3) **Lupus of the pharynx** usually occurs as a direct extension from the nose or from the larynx, but it may occur also as an extension from the fauces, in which case the base of the uvula is a common starting point. The process consists of a gradual infiltration producing a local nodular thickening and hyperæmia, which may be followed by ulceration. The infiltration is similar to that of lupus of the skin in that there is no tendency to spread into the deeper tissues. The condition is distinguished from tuberculous infection, malignant disease and syphilis by the slowness of extension, lack of pain, absence of fixation or œdema, and the fact that there is no destruction of any submucous tissue.

Treatment must be directed to improving the general health, resting the affected area, and if this is localised, destruction of the diseased area by the galvano-cautery, diathermy cautery or curette.

Primary malignant disease of the pharynx is fairly common, and it is frequently observed as an extension from the larynx, tongue, fauces or neck. *Epithelioma,* however, may originate in the lateral wall of the pharynx, especially in the deeper parts. It manifests itself as a crateriform infiltrating ulcer, and the first symptoms noticed are slight dysphagia and pain shooting up the side of the neck to the ear on the affected side. If diagnosed sufficiently early, the ulcer may be removed by means of one of the operations devised for opening the pharynx externally (vide p. 350).

A **retropharyngeal abscess** consists of a collection of pus in the connective tissue behind the posterior pharyngeal wall. The abscess may be either of the acute or chronic variety.

(*a*) *Acute retropharyngeal abscess* is much more common in children than in adults, especially from the first to the sixth year. The abscess forms either as a result of direct infection from the pharynx, from an abrasion, or as an infection from the nasopharynx or tonsil, causing inflammation and suppuration in one of the cervical glands in the retropharyngeal space. The condition is often a complication of one of the acute specific infective fevers.

There is marked pyrexia, pain on moving the head, dysphagia, and there may be dyspnœa also. Some œdema of the neck may be seen externally, but in any case the fluctuating swelling seen by examining the pharynx is characteristic. The condition is diagnosed from peritonsillar abscess by the fact that both pillars of the fauces are to be seen in front of the swelling.

The *treatment* should not be delayed on account of the danger of the pus spreading along the fascial planes of the neck into the mediastinum and also on account of the risk of œdema of the glottis supervening. The abscess must be opened into the pharynx at once; no anæsthetic is necessary, and is indeed dangerous. The patient should be placed on his back and the table tilted to as acute an angle as possible, so that the head hangs nearly in the vertical position, the mouth is held open with a gag, and under direct observation a knife is inserted through the wall of the abscess at its most prominent point and the pus evacuated completely. The position of the patient and the absence of anæsthesia will prevent the pus escaping into the trachea, and the mouth should be swabbed clear carefully before the horizontal position is reverted to.

(*b*) *Chronic retropharyngeal abscess* generally follows tuberculous caries of one of the cervical vertebræ, in which case the pus is situated behind the prevertebral fascia (see p. 128). It also may be due to the breaking down of a deep cervical gland which is the seat of chronic tuberculous infection. In all cases tuberculous caries of the spine must be excluded. As in the acute variety, the abscess forms a tense elastic swelling situated behind the posterior pharyngeal wall, but it is painless and does not cause dysphagia; pyrexia is unusual, and the whole onset is much more insidious. In an adult it has to be diagnosed from a gummatous infiltration or a retropharyngeal new growth.

The *treatment* of a chronic abscess should not be delayed unreasonably, as sooner or later it will burst either externally or into the pharynx and thus become secondarily infected. If the abscess is pointing on the outside of the neck as well as in the pharynx it should be opened and treated in a manner exactly similar to that described for dealing surgically with breaking down glands of the neck.

Usually the swelling only evinces itself in the pharyngeal wall, and provided caries of the cervical vertebræ has been excluded it can be safely opened into the pharynx itself.

The child should be anæsthetised and the head placed in the position recommended for tonsillectomy. The mouth is gagged open and the abscess contents aspirated through a suitable cannula. A vertical incision is then made and the contents finally and thoroughly evacuated by pressure. No curetting should be attempted. Where there is evidence of disease of the cervical vertebræ the abscess should be opened by dissection behind the sternomastoid muscle and dealt with in the ordinary way.

OPERATIONS FOR MALIGNANT DISEASE OF THE FAUCES AND PHARYNX

In all cases in which an operation is proposed for the extirpation of a growth in this locality the closest attention must be given to the question whether or not there is a reasonable prospect of cure. Where the growth is small, non-adherent, and there is no sign of secondary enlargement of cervical glands to be detected, there is no question but that early operation offers a chance of complete cure. In cases where the primary growth itself is removable, but in which a few hard secondary glands can be felt, it can be looked on also as reasonable to remove the growth, provided the glands are thoroughly dealt with as well. On the other hand, where the pharyngeal swelling is ill-defined, fixed and continuous with a mass of glands in the neck, operation is contra-indicated.

(1) *Operation through the mouth* alone may be undertaken in cases where the growth is small, or localised to the tonsil itself, and where there is no evidence of secondary glandular infection. Even in such cases, however, it may be considered advisable to remove the lymphatic glands draining the area soon after the intrabuccal operation, as these may be infected even though no evidence can be detected clinically. In the case of a growth confined to one tonsil, an incision is made in the soft palate lateral to the uvula on the side affected and the tonsil completely removed, together with part of the anterior and posterior pillars and a portion of the base of the tongue.

Bleeding is the only serious difficulty likely to be encountered in performing this operation, and for this reason many surgeons now make use of the diathermy cautery in carrying it out. In the event of its employment chloroform must be the anæsthetic employed. The entire operation can be performed without any hæmorrhage, and at the same time by regulating the spark the surgeon can observe exactly what structure is being dealt with at any stage of the operation. There is no more danger of secondary hæmorrhage occurring after the employment of diathermy than after excision by ordinary dissection with ligation of the vessels.

(2) *Lateral Pharyngotomy.* Too great stress cannot be laid on the fact that all sources of septic infection of the mouth and nose must be completely eradicated before any operation from the neck exposing the pharynx, larynx or œsophagus is attempted. It is usually necessary to remove all the patient's teeth as a preliminary procedure. Intratracheal administration of gas and ether is the anæsthesia of choice for this operation, the positive pressure obtained in the trachea by this method helping to prevent blood from escaping downwards into the lungs. As the glands have

to be dealt with, an incision is made along the anterior border of the sternomastoid muscle, extending from the mastoid process downwards, at least two-thirds of the distance to the sternum, and a second incision is carried forwards from this at the level of the hyoid bone, curving upwards to the mandible, and to the side of the chin. The facial vessels are divided and the submaxillary salivary and lymphatic glands thoroughly cleared out from above downwards. All the branches of the external carotid are ligatured and divided and, if necessary, the external carotid artery is extirpated; otherwise it is retracted backwards. The muscles overlying the pharyngeal wall are divided, but the lingual, hypoglossal and glossopharyngeal nerves should be spared, if possible. The superior laryngeal nerve, especially, should be divided only as a last resort. The pharyngeal wall is now exposed; and by means of a finger in the pharynx the primary growth may be cut out with scissors, with as free a margin as possible. Great care must be taken in suturing the pharyngeal wall, and this is best carried out by means of separate mattress stitches of catgut, which are only applied to the external layer of the pharyngeal muscles. The skin incisions should not be closed completely, but allowance should be made for free drainage by means of rubber drains stitched to the skin wound and left for at least forty-eight hours. In order to facilitate feeding subsequent to the operation without straining the sutures by muscular action, a soft rubber tube may be passed through the nose down to the stomach and retained in position for ten days, all nourishment being given in liquid form by this means.

In certain cases this operation may be extended further by division of the mandible. The incision is the same, except that its horizontal branch towards the chin is continued further on to the face and the upper flap dissected further up, the mandible being divided in front of the masseter muscle.

(3) *Median pharyngotomy* is an operation devised for obtaining access to growths of the epiglottis and root of the tongue. It can be performed under anæsthesia by intratracheal gas and ether. An incision is made along the whole length of the hyoid bone, and from the middle of this another incision is carried down in the midline to the thyrohyoid membrane and thyroid cartilage, the infrahyoid muscles are divided at their attachment to the hyoid bone and the pharynx opened by an incision below and parallel to the hyoid bone. The epiglottis is seized and hooked out of the wound, which is retracted well open, and any growth dealt with by excision. If necessary, the thyroid cartilage can be split in the midline and the aryepiglottidian fold and ventricular band removed on the affected side. If any more extensive operation is required the growth may be considered inoperable from the standpoint of expecting a cure.

(4) During the last decade radium has been increasingly made use of in the surgical treatment of malignant disease of the upper air and food passages. Operations are planned which aim at removal or partial removal of the infected glands and primary growths, and at the same time radium needles are planted in the tissues infected or suspected of infection. In the fauces, pharynx and larynx it is very difficult to maintain these needles in position if they are applied from the buccal aspect. It is therefore much more satisfactory to approach the diseased area through an external incision.

By using radium quite a number of cases can be greatly relieved, and in many more the progress of the disease is retarded, but it must be accepted that complete excision of the growth, if it is possible, is still a more satisfactory procedure. When the deep pharynx is the seat of malignant disease which is to be treated with radium it will often be necessary to do a preliminary tracheotomy. In other cases the airway should be carefully watched while the radium is in position, and if there is any evidence of impending respiratory obstruction a tracheotomy should be performed.

External applications of radium (radium collar) are often made use of after a successful operation and deep X-ray therapy is now generally acknowledged to be an additional but necessary treatment.

THE ŒSOPHAGUS

Examination of the Œsophagus. This may be done:—

(1) By radiography.

(2) By direct œsophagoscopy.

Since the introduction of the œsophagoscope and the examination of the passage of opaque matter on the fluorescent radiographic screen the surgeon is no longer justified in passing a bougie for the purpose of examination of the lumen of the œsophagus.

(1) Most conditions of the œsophagus can be diagnosed now by means of X-rays and the use of the fluorescent screen. Pieces of metal are demonstrated readily by exposing a film, but the presence of even a large piece of bone in the thoracic part of the œsophagus will usually be missed owing to the blurring caused by the vertebræ and ribs.

The passage of a bolus of opaque food or emulsion can be examined throughout the entire length of the œsophagus by means of the fluorescent screen. The patient stands upright, swallows the emulsion when told to, and the surgeon watches its passage through the œsophagus. The viscosity of the opaque emulsion swallowed is a matter for the surgeon to decide for himself, but a satisfactory view is obtained with an emulsion of the consistency of thin porridge.

In the normal œsophagus this emulsion shoots straight down into the stomach, only taking about a second to pass the whole 10 inches of the tube. It may be delayed slightly by the presence of a small foreign body or completely obstructed by a new growth of the œsophageal wall or mediastinum, or by a tight spasm at the cardiac orifice of the stomach. If a photographic film is taken after the passage of the barium or bismuth emulsion, the presence of a foreign body or small ulcer may be shown by the fact that some of the emulsion remains adherent at this point.

It is always advisable to take a film of the œsophagus during the passage of the emulsion, as well as to carry out the examination on the screen, as sometimes an abnormality which is missed on the screen is shown on the film and vice versa.

It is usually possible to determine the length of œsophagus involved in the growth by this means, owing to the irregular outline which occurs wherever the œsophageal wall is the site of disease. Obstruction situated in the first inch of the œsophagus is very difficult to demonstrate by X-ray examination.

(2) The *œsophagoscope* consists of a long tube which is attached to a handle exactly similar to that described for direct laryngoscopy and tracheoscopy, and its method of application is very similar (p. 365).

The operation is sometimes carried out under local anæsthesia, but more usually under a general anæsthetic. The œsophageal tube is passed through the mouth and pharynx, with the patient in the same position as for laryngoscopy and tracheoscopy under general anæsthesia, except that the head should be slightly more flexed. When the arytenoid cartilages come into view the end of the tube is slipped past them and engages in the upper end of the œsophagus. This manœuvre is sometimes resisted by a muscular spasm, and in this case it is important not to use force, but to keep the end of the tube in contact with the posterior pharyngeal wall and wait for the spasm to relax, insinuating the tube by keeping it gently pressed towards the vertebral column. If any force is used troublesome hæmorrhage may start, and the subsequent view is partially obscured. Once the œsophagus is entered the tube is gradually pushed down, under direct observation, as far as the entrance to the stomach.

In an adult the tube, if circular, should not be more than 2 cm. in diameter.

As the tube is passed into the lower third of the œsophagus it is necessary to lower the patient's head to allow for the forward curve of the tube towards its opening through the diaphragm. In all cases 1/75 of a grain of atropine sulphate (adult dose) should be given half an hour before the operation and, if possible, no food should be given by the mouth for twenty-four hours previously. Food, débris, etc., greatly impair the view obtained, and their removal protracts the operation. Whenever possible a suction apparatus should be available to withdraw secretion, etc., from the œsophagus as the examination is proceeded with.

Dysphagia. By this term is meant a condition in which swallowing is either difficult or painful.

When a patient presents himself complaining of dysphagia, examination should be carried out systematically, and if this is done there rarely should be any difficulty in arriving at a diagnosis.

(1) The age and general condition of the patient should be noted carefully and a history as to the mode of onset of the symptoms elicited. If its onset was acute, it is due probably either to the presence of a foreign body or some form of neurosis.

(2) The condition of the mouth and pharynx should be inspected thoroughly both directly and by means of the indirect laryngoscope. The larynx should be examined, whether any laryngeal symptoms are present or not

(3) The condition of the neck should be noted in case there is any external swelling, visible or palpable.

(4) The chest must be examined carefully, and this is most satisfactorily carried out by radiography with the aid of opaque emulsion.

(5) Finally, after all the foregoing examinations have been made, the œsophagus should be examined by means of the œsophagoscope.

The causes of dysphagia are very numerous and may be arranged as follows:—

(1) Extrinsic. (2) Intrinsic.

(1) *Extrinsic*, due to outside pressure on the gullet.

(*a*) *In the neck.*

Cervical adenitis with or without abscess formation and retropharyngeal abscess.
Any form of enlargement of the thyroid gland, usually malignant disease.
Malignant disease of any structure in the neck other than the pharynx or œsophagus.
Aneurysm of one of the vessels in the neck.

(*b*) *In the thorax.*

Aneurysm of the aorta and large vessels.
Growths of the mediastinum, lung or vertebral column.
Enlarged mediastinal glands.
Dislocation of the sternal end of the clavicle.

(2) *Intrinsic.*

(*a*) *Pharyngeal.*

Impaction of foreign bodies.
Acute or chronic tonsillitis.
Acute or chronic pharyngitis.
Syphilitic ulceration (painless).
Stenosis due to scarring.
Malignant disease.
Hysterical spasm, globus hystericus.
Bulbar paralysis.

(*b*) *Laryngeal.*
- Acute or chronic laryngitis.
- Tuberculous laryngitis (very painful when advanced).
- Syphilitic disease (painless).
- Malignant disease (advanced).

(*c*) *Œsophageal.*
- Impaction of foreign bodies.
- Acute or chronic inflammation.
- Syphilitic disease (gummata and ulcers).
- Diverticulum.
- Œsophagospasm (Achalazia).
- Simple or malignant stricture.
- Interference with œsophageal movements by bulbar paralysis.

Malformations of the Œsophagus. (*a*) *Congenital.* Congenital stricture of the œsophagus is sometimes met with at the cardiac end, and the lumen of the tube may be completely absent for an inch or two. More commonly there is a stricture of the œsophagus just above the level of the bifurcation of the trachea, and the lower end of the œsophagus communicates with the trachea. Sometimes there is simply a small fistula between the trachea and œsophagus. These conditions are only seen in infants at birth, and the children invariably die almost at once.

(*b*) *Acquired malformations* consist of the development of the so-called diverticula, of which two varieties are described: (1) Pressure diverticula; (2) Traction diverticula.

(1) **Pressure Diverticula.** These always arise from the posterior wall of the deep pharynx at its junction with the œsophagus (*i.e.*, just below the margin of the inferior constrictor muscle of the pharynx), in which situation there seems to be a weakness and probably also an abnormal exposure to pressure. They are therefore really pharyngeal diverticula rather than œsophageal. The wall of the pharynx at this spot commences to bulge, and the continued pressure of food impinging against it causes a sac gradually to develop, which, as it gets larger, sags down into the neck between the œsophagus and the vertebral column. As it increases in size the fundus of the sac may hang as low down as the fourth thoracic vertebra. The diverticula develop very slowly, so that symptoms are not usually noted before the age of forty. The wall of a diverticulum is thin and is simply composed of the structural elements of the pharynx and œsophagus considerably stretched and attenuated. When a diverticulum exists an œsophagoscope which is used with the intention of passing down the œsophagus invariably gets caught up in the pouch.

The *symptoms* complained of are very gradually increasing dysphagia, with occasional regurgitation of undigested or putrefying food, accompanied by a certain amount of pain. There may be a history of several years' standing, but when the pouch has reached a considerable size the dysphagia is marked and a varying amount of regurgitation is constant. There is also definite emaciation. Sometimes a lump can be felt in the neck on the left side, and on pressure from outside regurgitation occurs. The dysphagia often does not come on until towards the middle or end of a meal, when the pouch becomes full and produces pressure upon the œsophagus.

The *diagnosis* has to be made from simple or malignant stricture. The slow onset of the symptoms and the regurgitation of undigested food which has been eaten a day or two previously serve as a guide to the distinction from stricture, but the only certain means of diagnosis is by means of an X-ray examination. The smooth, round appearance of the fundus of the pouch filled with bismuth emulsion is quite characteristic (vide Plate I.); it may be as large as an orange, and generally lies behind and to the left side of the œsophagus. When this picture is seen by radiography it is unnecessary to confirm its presence by means of the œsophagoscope.

The only treatment possible is by operation. The sac may be obliterated by excision or by a form of diverticulopexy. The fundus of the sac can be stitched high up in the neck so that food does not get caught in the pouch. An incision is made along the anterior border of the sternomastoid muscle on the left side, the carotid sheath retracted backwards, the lateral lobe of the thyroid gland defined and the vessels to it divided. The œsophagus is thus exposed and the pouch searched for. The pouch can be shelled out readily from the thoracic inlet by blunt dissection and pulled up into the neck, but care must be taken not to handle it roughly on account of the thinness of its wall. At this point one of three plans may be adopted.

(*a*) The fundus of the sac is pulled high up into the neck and sutured to the under surface of the sternomastoid or to other neck muscles. As a result of this ingested food does not get caught in the pouch.

(*b*) The diverticulum is excised and the œsophageal opening closed with mattress sutures.

(*c*) The operation mentioned in (*a*) is performed, the wound closed, and at an operation carried out one month later the sac is excised.

The advantage of (*a*) is that it is the least dangerous operation, the gullet not being opened.

In the case of the last mentioned, the interval of one month allows for the formation of scar tissue and adhesions which shut off the fascial planes and mediastinum from possible infection at the second stage.

(2) **Traction diverticula** are much rarer and occur as the result of cicatricial contraction from without. This may be the result of an infected and inflamed bronchial gland or due to malignant disease. Traction diverticula are most common near the bifurcation of the trachea. They cause no symptoms and are not of surgical importance.

Inflammation of the œsophagus occurs only as the result of impaction of a foreign body or following the swallowing of corrosive liquids. The symptoms are pain and dysphagia, and the treatment consists of resting the part by restricting the diet to non-irritant fluids or, if necessary, rectal feeding for a few days.

So-called **hysterical spasm of the œsophagus** or globus hystericus is usually seen in neurotic young women. There is difficulty in deglutition, and the patient complains of the sensation of a ball rising in the throat due to spasmodic action of the constrictor muscles of the pharynx and other muscles in the neck connected with the larynx and pharynx. If the patient's attention is diverted deglutition may take place quite normally. An X-ray film shows no obstruction to the passage of food once it has entered the upper end of the œsophagus. The condition must be distinguished from a true spasm of the œsophagus (see p. 361).

Treatment is antineurotic in character, cold douching to the back, massage, and the administration of tonics, purgatives, etc. If the case proves resistant to treatment it is useful to try the passage of œsophageal bougies.

FOREIGN BODIES IN THE ŒSOPHAGUS

Foreign bodies frequently lodge in the œsophagus, especially in children. The commonest substances found are coins and portions of toys in children, in adults fish bones, pieces of meat bone, pins, nails, and plates of false teeth.

Foreign bodies of relatively large size are impacted nearly always in the first 2 inches of the œsophagus, but in the case of pins and small spicules of bone the surgeon must be prepared to meet with them at any level, particularly just above the entrance to the stomach.

The patient complains of pain on swallowing, referred either to the neck or sometimes more indefinitely to the middle of the chest. There may be complete obstruction to fluids and solids, or fluids may be swallowed fairly easily whereas solids are regurgitated, according to the degree of obstruction. There is usually a history of the patient knowing that he has swallowed a bone or some other foreign body, but in children this may not be available, and the only indication is dysphagia and the fact that some toy or coin cannot be found. In adults bones are particularly liable to find their way into the œsophagus when the patient has been hurriedly swallowing meat broth, Irish stew or fish pie in which he does not necessarily suspect the presence of a piece of bone. If a foreign body remains fixed in the œsophagus it will cause ulceration and perforation eventually, followed by mediastinal abscess or cellulitis. Sometimes the foreign body, if sharp-edged or pointed, ulcerates directly into the aorta. The sooner, therefore, any impacted substance is removed the better, and the larger and more jagged its edge is, the more urgent is the call for immediate treatment. Smooth foreign bodies, such as coins or buttons, may remain impacted in the œsophagus for days without causing ulceration.

If the presence of a foreign body in the œsophagus is suspected, only two methods are justifiable as a means of confirming the diagnosis—radiography and the use of the œsophagoscope. Any body which is opaque to the X-rays can easily be seen if large enough, but in the case of bones impacted in the intrathoracic part of the œsophagus this means of detection is not reliable. The passage of an opaque emulsion may be observed on the radiographic screen, and a slight check in its passage may denote the presence of obstruction. The only certain method of detecting the presence of a foreign body is by means of the œsophagoscope, and where there is any doubt as to the condition this means of diagnosis always should be employed.

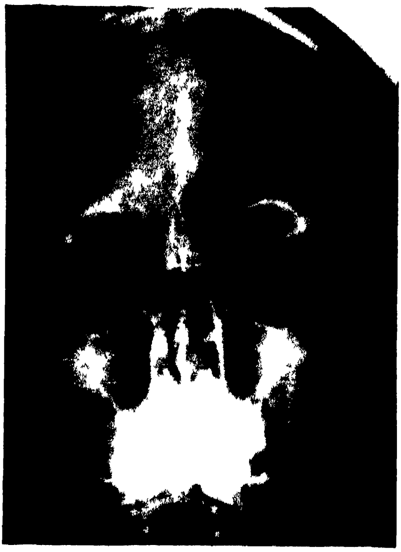
Treatment varies slightly according to the size and situation of the impacted body.

If an œsophagoscope is not immediately available for the treatment of these cases it is much better to wait until the patient may be moved to a suitable hospital or the instrument itself obtained.

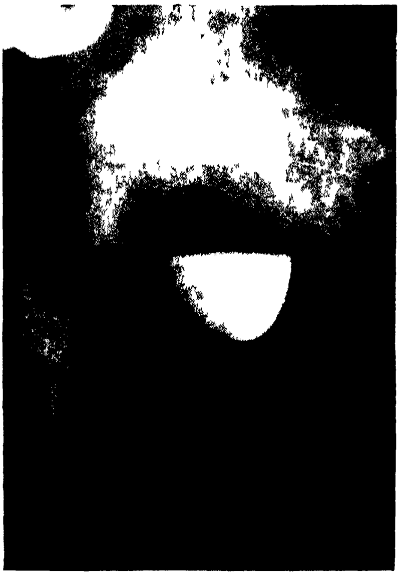
In infants and young children coins impacted in the upper end of the œsophagus can usually be removed by means of the œsophagoscope without the administration of a general anæsthetic.

When an adult is being dealt with, and especially if the foreign body is of large size and irregular in shape, a general anæsthetic is necessary. The longer the substance has been in position and the larger it is, the more difficult will be its removal, owing to swelling and œdema of the œsophageal wall. In all cases an attempt should be made to remove the foreign body by the mouth before an open operation in the neck is undertaken, and special

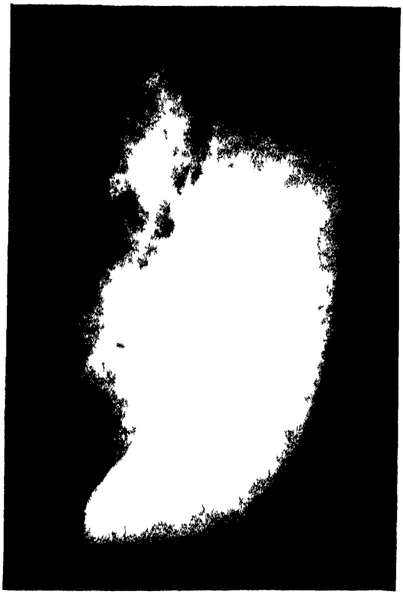
PLATE I.



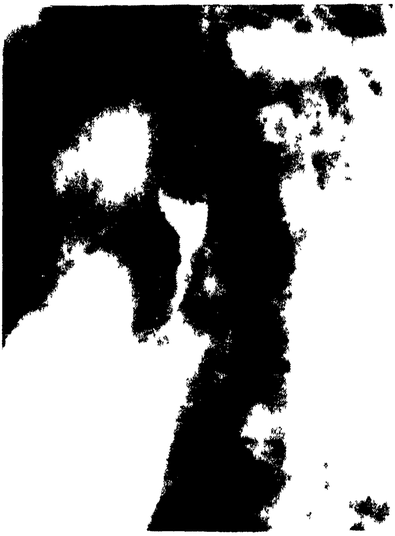
Showing the presence of pus in the Right Frontal Sinus.



Hypopharyngeal (often called "œsophageal") pouch partially filled with opaque emulsion.



Enormously dilated œsophagus filled with opaque emulsion which is held up by muscular spasm at the level of the diaphragm.



Malignant stricture of the œsophagus at the level of the bifurcation of the Trachea. (Opaque emulsion passing through.)

instruments have been devised for breaking up the obstruction in situ in order to facilitate disimpaction.

If the foreign body cannot be dislodged by this means and is situated in the first few inches of the œsophagus, as it usually is, the operation of **lateral œsophagotomy** must be performed.

An incision, 4 inches long, is made along the anterior border of the sterno-mastoid on the left side. The anterior border of the muscle is defined and retracted outwards. Next the carotid sheath is also defined and retracted outwards. The thyroid vessels and nerves may require division, but care must be taken not to injure the left inferior laryngeal nerve. When the œsophagus is clearly defined, and this will be rendered easier by the presence of the foreign body, its wall is incised longitudinally and the obstruction removed. The œsophageal wound may be closed by mattress sutures which do not include the mucous membrane, but the external wound should be left open and free drainage must be allowed for several days owing to the danger of a spreading cellulitis of the neck. Feeding should be by means of a nasal tube for ten days as described for lateral pharyngotomy (p. 350).

In the case of foreign bodies impacted near the cardiac orifice, failing removal by the œsophagoscope, it may be possible to push them into the stomach under direct observation, or laparotomy may be performed, the stomach opened and the obstruction removed by this route. Once the foreign body has passed into the stomach purgation must be avoided, and if it is not of large size and irregular shape the case should be left to nature, treatment otherwise being merely expectant. The patient should eat normal food, excess of fluids being avoided, and the course of the foreign body watched by radiography. If it becomes arrested at any particular point for a considerable time, or if any signs of inflammatory reaction supervene, laparotomy should be performed at once for its removal. A halfpenny usually will pass through a child of six months and a penny through a child of four to five years, but it is worth adopting expectant measures for even larger foreign bodies than these.

Spontaneous Rupture of the Œsophagus is a very rare condition, usually occurring in men who have systematically dined and wined well. While vomiting a sudden acute pain is felt in the epigastrium, usually radiating to the left and marked collapse occurs. The rent occurs just above the diaphragm.

On examination air and fluid can be detected in the left pleural sac in most cases, though more rarely the rent in the œsophagus opens into the mediastinum. Fluid withdrawn shows an acid reaction and contains stomach contents. The upper abdomen is rigid and tender and the patient sits up, in extreme agony.

Treatment consists in opening and cleansing the left pleural cavity and suturing the œsophageal rent, if this is fairly easy of access. A gastrostomy should be performed and the patient allowed nothing by mouth for at least ten days, if he survives.

Diagnosis is from perforation of a gastric ulcer, gastric crisis, diaphragmatic pleurisy or acute pancreatitis. The prognosis is very grave, all reported cases being fatal.

STRICTURE OF THE ŒSOPHAGUS

This occurs in two forms, (1) simple or fibrous, (2) malignant.

(1) **Fibrous stricture of the œsophagus** is usually the result of trauma, but

it may be the result of cicatrisation following a gumma or around inflamed mediastinal glands. The trauma is caused either by the impaction of a foreign body or by the swallowing of hot or corrosive fluids. The corrosive fluid first causes ulceration and inflammation, and if this is recovered from, the subsequent healing and scarring produce contraction of the lumen of the œsophagus, which may be sufficient to cause complete obstruction through several inches of its length. In the case of a relatively mild corrosive, such as solution of caustic soda, the cicatricial contraction may not give rise to obstruction until several months have elapsed.

The commonest situations for these strictures to arise are either at the entrance to the œsophagus, at the level of the arch of the aorta, or at the cardiac orifice, the reason for this being that liquid passing normally through the œsophagus is delayed for a fraction of a second at these three levels. Sometimes there is a separate stricture in each of these situations.

Strictures are said to occur at the cardiac orifice as a result of scarring following a gastric ulcer.

The chief symptom complained of is gradually increasing difficulty in swallowing, at first of solids, but later of fluids also. This is accompanied by a feeling of discomfort or pain during the act of deglutition. If the stricture is at the upper end of the œsophagus the food is regurgitated at once, but if lower down or at the cardiac orifice, it may be retained for several hours, and then part of the meal is returned undigested. In the latter case there is gradual distension of the œsophagus above the stricture, and it is in this distension that the food collects. The site of the stricture can be seen readily by radiography, and the X-ray picture is different from the irregular shadow seen in cases of malignant stricture. In the case of mere narrowing of the œsophagus due to fibrous stricture, foreign bodies which would pass easily through a normal œsophagus may become impacted and give rise to acute symptoms.

Treatment. (*a*) In cases in which there is reason to expect that a stricture will develop as a result of ulceration, operation, or the swallowing of corrosive fluid, it is advisable to take steps to keep the lumen of the œsophagus clear by the occasional passage of flexible œsophageal bougies. This should not be attempted, however, until all the acute symptoms have passed off and actual ulceration of the mucous membrane of the œsophagus has healed. An interval of at least a few days should be allowed to elapse between each dilatation, and the first should be carried out only under direct observation with the œsophagoscope; subsequent dilatations may be carried out without this precaution.

(*b*) Once a stricture has formed, dilatation by means of the passage of gum elastic bougies increasing in size at regular intervals is the most satisfactory line of treatment. The first operation should be carried out with the œsophagoscope and care should be taken not to cause too much stretching at any one time, as this tends to produce further reactionary contraction later. Even when the stricture seems to be well dilated it is probably safer to pass a bougie occasionally at long intervals to make certain the contraction does not recur. In order to pass an œsophageal bougie the patient is made to sit upright in a chair with the head held slightly forward and the mouth open. The end of the bougie should be lubricated with glycerine and, having been suitably curved, is guided by the surgeon over the base of the tongue, past the epiglottis and into the œsophagus. This stage usually causes a certain amount of retching on the part of the patient. Once the tip is engaged in the entrance to the œsophagus the bougie should be pushed steadily onward until the end is 16 inches from the teeth, when it will be at the entrance to the stomach.

(*c*) If the stricture recurs rapidly and relief by dilatation is only transitory a firm rubber tube may be passed through and retained in position for ten days, the upper end being drawn out of the mouth and fixed. Or a more satisfactory method is to insert a special funnel-shaped tube such as a Symond's tube, made of gum elastic, or a flexible metal Souttar's tube. These may be left in position for two or three months, and when they are removed it is often found that the stricture has been dilated by their continued presence.

(*d*) It may be necessary to incise the stricture under direct observation with the œsophagoscope before a tube can be inserted through the stricture. Such treatment may be tedious, as it always must be remembered that the stricture may extend for a considerable length of the œsophagus or one or more additional strictures may exist beyond the one which actually can be seen.

(*e*) If the cardiac orifice is involved it is sometimes necessary to open the stomach by laparotomy and perform a retrograde dilatation, subsequent dilatations being kept up by regular application of the œsophageal bougie.

(*f*) As a final resort gastrostomy (vide p. 641) may be required, and it is sometimes found that as a result of the rest given to the œsophagus the stricture will yield and dilatation become practicable, the stomach opening then being allowed to close.

(2) **Malignant stricture of the œsophagus** is usually primary and epitheliomatous in type, but it does occasionally occur as an extension of a mediastinal or thyroid growth. An epithelioma may arise anywhere along the length of the œsophagus, but it is most common opposite the bifurcation of the trachea, the next commonest situations being post-cricoid and at the cardiac orifice. If malignant disease occurs at the cardiac orifice it may originate in the stomach, in which case it will be of the columnar-celled variety. The disease is not often seen before the age of forty, and is most frequent between the ages of fifty and sixty. The victims usually suffer from severe pyorrhœa alveolaris and septic teeth. The growth commences as an ulcer on the œsophageal mucous membrane, developing the typical proliferating indurated margin with central ulceration, and the projecting mass of the growth may be the first cause of the œsophageal obstruction. As it increases in size it involves the whole of the circumference of the œsophagus. Secondary deposits take place in the lymphatic glands, but unless the growth is high up and of considerable standing the enlarged glands are not palpable in the neck. As the growth progresses and ulcerates perforation may take place into the mediastinum, pleural cavity, or lung, giving rise to pneumonia. Communication with the trachea is very rare, and if it occurs is more likely to be due to a syphilitic ulcer. If not carried off by pulmonary complications, the patient usually dies of starvation.

The *symptoms* are very characteristic, and the most definite is gradually increasing dysphagia, solids being obstructed at first and later fluids also. The increase in the difficulty in swallowing is usually fairly rapid, and sometimes only two months elapse between the first symptom noticed and the onset of complete obstruction to fluids. Pain is not always present in the early stages, but is noticed when swallowing is attempted; in the later stages the pain may become more marked and constant.

If the growth is in the upper part of the œsophagus the food is regurgitated at once in the same way as has been described for fibrous stricture in this situation. At this level one or both inferior laryngeal nerves may become involved in the growth, giving rise to laryngeal paralysis. When the growth occurs low down in the œsophagus there is dilatation and retention of food above it similar to that which occurs with a fibrous stricture.

The condition has to be diagnosed from simple stricture of the gullet, and this usually can be done by referring to the history. The presence of a pouch or spasmodic contraction of the œsophageal wall can be excluded only by radiography and the use of the œsophagoscope. With a malignant stricture the patient frequently coughs or hawks up blood-stained mucus. This is an unusual symptom of fibrous stricture. The emaciation of the patient is much more rapid and marked in malignant disease of the œsophagus than in obstruction due to any other cause, but it must not be forgotten that a considerable amount of wasting may result from lack of nutrition due to simple œsophageal obstruction. Radiography should be carried out always before the œsophagoscope is used in case the symptoms are due to an intrathoracic aneurysm. A portion of the stricture may be removed for microscopical examination.

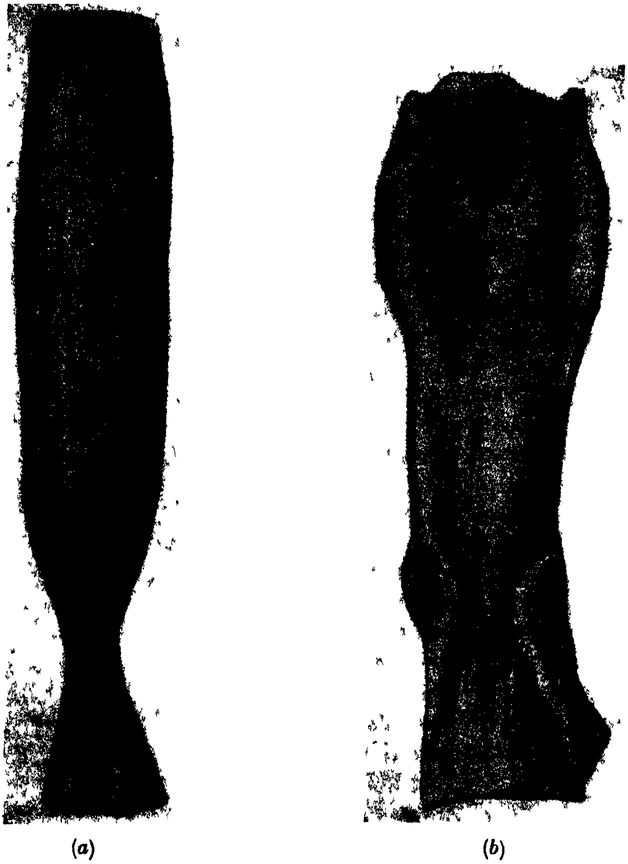

(a) (b)

FIG. 127. (a) Dilated œsophagus due to cardiospasm. (b) An œsophagus laid open and showing a malignant stricture.

The *treatment* of malignant disease of the œsophagus is very unsatisfactory, as even if the disease is diagnosed in its early stage, it is only very rarely that removal can be attempted by any surgical operation, owing to its inaccessible situation. Palliative treatment is therefore all that is possible and should aim at preserving the lumen of the œsophagus for as long as possible. The following methods have been tried with varying success:—

(1) By means of the œsophagoscope a flexible metal tube (*Souttar's Tube*) is introduced and left in the stricture, remaining in position indefinitely. Fluid food can then be swallowed comparatively successfully. It may be necessary to dilate the stricture before introducing the Souttar's tube.

(2) The growth may be partially destroyed and the lumen of the œsophagus improved by the use of diathermy applied by means of a long electrode with a specially made terminal.

(3) Radium may be introduced and fixed for a time within the stricture (as is a Souttar's tube) or radon seeds may be inserted with a special œsophageal introducer, the seeds being planted into the growth.

(4) Attempts have been made to attack the growth through the chest wall with a view to applying radium or attempting excision.

Although relief for varying lengths of time has been reported as a result of attempts on the above lines, it is doubtful if a cure has ever resulted.

Gastrostomy will have to be resorted to in a large number of cases, and if it is decided to perform this operation, the sooner it is done the better. In the majority of cases the gastrostomy is performed only when the patient is in the last stages of cachexia and starvation, and the shock of the operation then frequently produces a fatal issue. If the gastrostomy is performed early in the disease, or as soon as definite evidence of commencing starvation is noticed, the patient may survive a considerable time. Following gastrostomy the œsophageal growth is not continually irritated by straining at food and its progress is retarded. In many cases, after a gastrostomy has been done, the rest to the œsophagus permits swallowing to improve for a time.

Spasmodic Contraction of the Œsophagus (Œsophagospasm, Achalazia, Cardiospasm). This is a condition in which there is a spasmodic contraction of the muscle surrounding the œsophagus just above the cardiac orifice of the stomach, the so-called cardiac sphincter. According to some authorities, the contraction and obstruction are due to a spasmodic action of the muscle fibres of the diaphragm immediately related to the œsophagus. More probably the condition is the result of some alteration in vagus nerve tone producing overaction of the involuntary constrictor muscle fibres, these being more numerous in this situation than elsewhere throughout the length of the œsophagus, in other words, a relative paralysis of the vagal impulses supplying the sphincter (see Vol. I., Ch. XII.). It is probable that in many cases the spasm has been present in a mild degree since infancy and that in adult life compensation fails in some way. Instances have occurred in children and the dysphagia has at times come on suddenly after or even during an acute illness. The dilatation sometimes extends through the diaphragm to the cardiac end of the stomach, while actual lengthening of the œsophagus may occur, so that the œsophagus will hold a pint or more. Marked muscular hypertrophy occurs except at the cardiac sphincter and hence it is more probable that the condition is due to a failure of relaxation than to a spasm. As a secondary result the epithelium becomes inflamed, flattened and ulcerated; this may possibly be the starting point of a carcinoma.

Cardiospasm is more common in women than men, and usually occurs between the ages of twenty-five and forty-five. The symptoms are gradually increasing dysphagia, in which the food seems to the patient to be held up deep down in the chest, passing on in anything from two minutes to half an hour, or the whole meal being regurgitated unchanged. Pain in the chest after a meal may be marked. Intermittent periods occur during which no difficulty in swallowing is experienced. In many cases there is more difficulty experienced in swallowing fluids than solids, and this symptom helps in making a diagnosis from malignant stricture.

The condition can be diagnosed by X-ray examination of the passage of bismuth emulsion, when the characteristic picture shown in Plate I. is seen, the emulsion being held up for a varying length of time until the spasm relaxes. The œsophagus eventually may appear enormously dilated.

Treatment is not satisfactory and almost certainly will be prolonged, but probably most benefit has been noted following the regular passage of a rubber tube or bougie containing mercury, the weight of the mercury forcing the rounded tip of the bougie through the unrelaxed lower end of the œsophagus. This may be repeated as often as once a day. Dilatation and stretching of the sphincter by means of a special dilator passed by the mouth under an anæsthetic has given good results. The stretching should be as wide as possible without rupturing the œsophageal wall, but this point is difficult to obtain without considerable risk. Regular dilatation with bougies is another method of treatment. Many other surgical procedures have been adopted with varying degrees of success. Thus plastic operations have been performed on the lower end of the œsophagus, or on the cardia of the stomach, and in instances where great œsophageal dilatation is present, a short circuit has been made between the œsophagus and the stomach.

More recently the operation of *gastric sympatheticectomy* has been introduced, though it is too early to say whether its results are permanently beneficial or not. The fibres concerned run along the coronary artery to the cardia and removal of the branch of the coronary artery to this end of the stomach has been performed.

It has been noticed that the spasm has been temporarily stopped by the administration of splanchnic anæsthesia. In the absence of these operative measures the administration of antispasmodics, belladonna mixtures and thyroid extract has been tried with varying success.

CHAPTER IX

THE LARYNX AND AIR PASSAGES

D. F. A. Neilson, B.A. (Cantab.), F.R.C.S. (Eng.)

Surgical Anatomy of the Larynx and Trachea. The *larynx* opens above into the lower part of the pharynx, and the air which passes from the trachea traverses the larynx, pharynx, and nasal fossæ during normal quiet respiration.

This relationship between the respiratory and digestive passages is explained by the fact that the respiratory apparatus is secondarily developed as an outgrowth from the primitive foregut of the embryo.

In man the upper opening of the larynx is situated lower down in the pharynx than it is in most mammals, and therefore nasal and buccal breathing may be carried on with almost equal facility. It is for this reason that any obstruction of the nasal airway is so readily followed by the development of mouth breathing and its attendant evils.

The larynx, or voice box, is mainly formed by the thyroid and cricoid cartilages, but includes the cartilaginous epiglottis and arytenoids.

Anteriorly in the midline, the prominent pomum Adami of the thyroid cartilage lies very superficially, being covered only by skin and two thin layers of fascia.

Laterally the larynx is more deeply placed between the great vessels of the neck and is partly covered by the lateral lobes of the thyroid gland.

The vocal cords are situated at the level of the fourth cervical vertebra, and are attached anteriorly to the angle between the alæ of the thyroid cartilage at a point from 6 mm. to 8 mm. below the bottom of the thyroid notch. Posteriorly the cords are attached to the vocal processes of the arytenoid cartilages.

The false vocal cords, or ventricular bands, are above the true cords, and are formed by the feeble superior thyroarytenoid ligament and a few muscle fibres covered with a fold of mucous membrane. They are attached anteriorly in the midline just above the true cords, and posteriorly they fade away on the lateral walls of the larynx near the cuneiform cartilage.

The rima of the glottis, or true glottis, is the name applied to the fissure which divides the upper and middle compartments of the larynx from the lower compartment; it is composed of two distinct parts:—

(1) An anterior portion between the true cords, known as the "glottis vocalis" or vocal glottis.

(2) A shorter posterior portion between the arytenoid cartilages, known as the "glottis respiratoria" or respiratory glottis. The rima glottidis undergoes constant alteration in shape by changes in position of the arytenoid cartilages, brought about by the action of the intrinsic muscles of the larynx.

The length of the rima glottidis varies in the sexes, and the average measurements are:—

Male—rima glottidis, 23 mm.; glottis vocalis, 15·5 mm.; glottis respiratoria, 7·5 mm.
Female—rima glottidis, 17 mm.; glottis vocalis, 11·5 mm.; glottis respiratoria, 5·5 mm.

The mucous membrane of the larynx is lined with ciliated epithelium, except over the true cords and on the posterior surface of the epiglottis, where the epithelium is squamous in type.

Over the vocal cords the mucous membrane is very thin, and tightly bound down. This fact is of surgical importance. In the condition known as "œdema of the glottis," the lax submucous tissue in the upper part of the larynx is liable to become infiltrated with fluid, which may proceed so far as to produce occlusion of the cavity. The close adhesion of the mucous membrane to the true cords prevents the œdema extending beyond the rima, and it is therefore possible to relieve the condition by opening the airway below this point.

Foreign bodies which become impacted in the true laryngeal cavity are nearly always found in the laryngeal sinus, *i.e.*, the space between the false cord and the true cord.

The whole of the laryngeal mucous membrane is extremely sensitive, and this sensitiveness is also present in the upper part of the trachea, but gradually diminishes to complete insensitiveness at the tracheal bifurcation.

In the operation of laryngofissure it is important to keep exactly to the midline when dividing the thyroid cartilage in order to avoid injuring one or other vocal cord, and it must be borne in mind also that the cartilage eventually becomes ossified, and may therefore present considerable resistance to division.

The *trachea*, being the continuation of the air passage beyond the cricoid cartilage, commences opposite the lower border of the sixth cervical vertebra. It ends opposite the upper border of the fifth thoracic vertebra and is 4 to 4½ inches long in the male and averages half an inch shorter in the female. The lower end of the trachea is immobile, but its wall is elastic and the trachea elongates or diminishes in length with movements of the head.

The trachea adheres rigorously to the midline, except towards its lower end, where it deviates slightly to the right, and as it descends it recedes rapidly from the surface following the curvature of the vertebral column.

Opposite the arch of the aorta there is a slight, but definite, diminution in the calibre of the trachea.

The tracheal walls are kept permanently patent by the cartilaginous hoops, which are from fifteen to twenty in number and are deficient posteriorly. Consequently the tube is not completely cylindrical, its hinder wall being flattened. The hyaline cartilaginous hoops are horseshoe-shaped, and are imbedded in the fibro-elastic membrane which passes round the whole circumference of the tube and which is continuous superiorly with the perichondrium investing the cricoid cartilage.

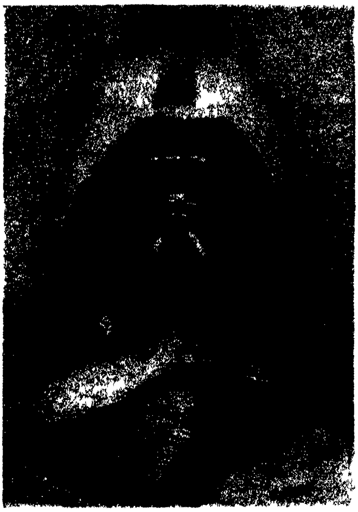


Fig. 128. Indirect laryngoscopy.

The musculus trachealis is a continuous layer of involuntary muscular tissue, placed on the posterior wall in front of the flattened fibro-elastic membrane. The muscular bundles are arranged transversely and are attached to the ends of the cartilaginous rings, and by their action markedly reduce the lumen of the tube.

Normally, in the adult male, the dimensions of the trachea are about 11 mm. antero-posteriorly, and 12·5 mm. transversely.

The trachea is lined with a lymphoid mucous membrane covered on its inner surface with columnar ciliated epithelium, the action of the cilia being in an upward direction.

The right and left main *bronchi* are exactly similar in structure to the trachea, the cartilaginous rings being deficient posteriorly.

The right bronchus is slightly larger than the left and takes a much more vertical course. Foreign bodies are more likely to lodge in the right bronchus, as it appears on examination with the tracheoscope to be almost a continuation of the trachea.

EXAMINATION OF THE LARYNX

Indirect Laryngoscopy. Before the student commences the practical study of diseases of the larynx it is essential that he should have attained a certain amount of skill in the practice of indirect laryngoscopy. The essential instrument for this is a circular mirror, very slightly concave or flat, set at an angle on the end of a metal stem and known as a laryngeal mirror (vide Fig. 128). The patient's mouth is widely opened, the examiner's left forefinger and thumb pull the patient's tongue gently but firmly forwards (a small piece of bandage cloth is used to obtain a firm hold on the tongue), the stem of the mirror is held in the examiner's right hand and the back of the mirror is placed gently against the soft palate so as slightly to elevate it. A beam of light is thrown on to the mirror, either from an electric head lamp on the surgeon's forehead or reflected by a frontal mirror from a suitable source of illumination (vide p. 298, nasal examination). This beam of light is thus again reflected on to the larynx by the laryngeal mirror, and the surgeon is able to examine the larynx and upper part of the trachea. It is always necessary to warm the laryngeal mirror before use to prevent condensation. Considerable practice is needed in order to obtain any degree of facility in the use of the laryngeal mirror, and also experience to be able to distinguish abnormal from normal conditions of the larynx. In some cases, where the faucial and pharyngeal mucous membrane is abnormally sensitive, it will be necessary to spray the throat with a 5 per cent. solution of cocaine before a satisfactory view can be obtained.

It must be remembered that the image of the larynx as seen in the mirror always is inverted, so that the arytenoid portion of the larynx appears at the lower margin of the laryngeal mirror. There is, of course, no reversal of the sides.

It is usually very difficult to obtain a view of the larynx in children, as they have not sufficient control to sit through the above described examination, and if it is absolutely essential to examine a child's larynx, recourse should be made to the direct laryngoscope.

Direct Laryngoscopy and Bronchoscopy.

Laryngoscopy. Several varieties of instruments are now made by means of which it is possible to make a direct examination of the larynx and trachea. Fig. 129 shows a common form of this apparatus, the essential part of which is a tubular spatula attached to a handle at an angle. The spatula holds the base of the tongue and epiglottis out of the way and enables the surgeon to make a direct inspection of the air passage. Illumination of the larynx is obtained, either by reflected light from a lamp and mirror in the handle, or by means of a small electric bulb at the distal end of the tube.

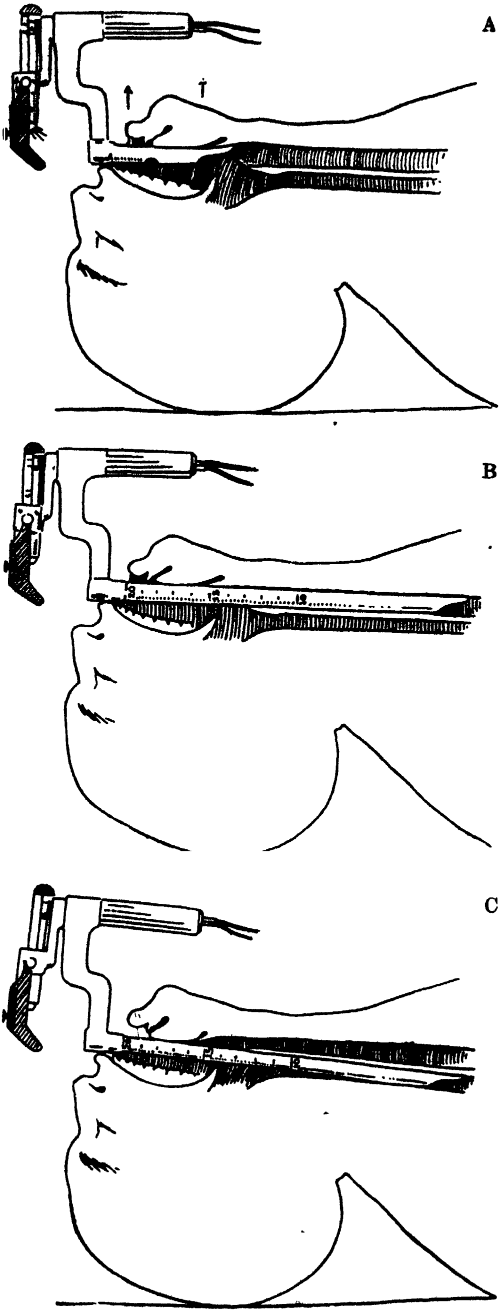


FIG. 129. (A) Direct laryngoscopy (diagrammatic). (B) Bronchoscopy (diagrammatic). (C) Œsophagoscopy (diagrammatic).

The patient should lie on his back on the operating table, with the neck slightly extended. The surgeon holds the handle of the laryngoscope in the left hand, passes the end of the spatula between the teeth, slides it along the dorsum of the tongue, and at the same time presses the tongue out of the way forwards. From the very start of this manœuvre observation is kept on the opening at the end of the spatula and landmarks in the pharynx are noted, the uvula, epiglottis and arytenoids being identified in turn. When the epiglottis is passed the distal end of the spatula must be pressed well forward in order to obtain a view of the vocal cords. If there is a spasm of the glottis, further examination should be delayed until the spasm relaxes for the patient to take a breath. The whole of the larynx and deep pharynx can now be examined, including the vallecula and pyriform fossæ, and probes and special elongated forceps may also be applied if necessary. Smaller sized spatulæ are made for use in children. In infants and young children the examination usually will have to be made under general anæsthesia. In adults it is always necessary to cocainise the pharynx and hypopharynx thoroughly, and the administration of a quarter of a grain of morphine will help to make the patient less sensitive. A general anæsthetic is frequently needed, especially if the examination is likely to be prolonged.

The laryngeal spatulæ are made so that they can be detached from the handle, and it is therefore possible by the use of longer tubes, specially modified, to extend the examination into the trachea.

Bronchoscopy. The tubes are of such a size and shape that they can be passed down the trachea and special sizes are made for children. The tube is passed as far as the vocal cords in exactly the same way as the laryngeal spatula or tube. As soon as the cords are seen to relax the distal end of the tube is passed between them and down as far as the bifurcation of the trachea. The entire bronchoscopic examination can be carried out under local anæsthesia.

The tracheal tubes are made in such a way that extension tubes may be passed into the right or left bronchus, and even into the first main bronchial divisions, and some tracheal tubes are made long enough and narrow enough in the first instance to be passed directly into the bronchi.

It is advisable to have a suction apparatus at hand for withdrawal of any excessive secretion by suction through a long fine metal tube, as in some cases the view is almost continually obscured by mucopus, etc., coughed up from the bronchioles.

FOREIGN BODIES IN THE AIR PASSAGES

Any part of the respiratory tract may become partially or completely obstructed by the presence of a foreign body, and the effects of this vary with the relative size and situation of the intruding substance.

(1) For impaction of foreign bodies in the nasal fossæ, see p. 299.

(2) The foreign bodies which become impacted **in the pharynx** are either sharp-pointed and small, such as spicules of bone and pins, or large masses of food. Fish-bones, pins, small pieces of wire, etc., may penetrate the wall of the pharynx or back of the tongue during the act of deglutition and be driven into the muscle so firmly that they require the application of considerable force before they can be withdrawn. They are found most commonly sticking into the tonsil, or just below it, and into the posterior surface of the tongue. They can be seen by use of the laryngeal mirror or by direct inspection with the use of a tongue spatula and may be removed with suitable forceps. For foreign bodies in the vallecula and pyriform fossa *vide* Foreign Bodies in the Larynx, p. 367. Only a large mass of food or a large foreign body is likely to become impacted opposite the pharyngeal entrance to the larynx, as a medium-sized mass will pass on and become fixed in the upper part of the œsophagus.

A foreign body such as a mass of food bolted hurriedly or inadvertently, becoming impacted at the mouth of the larynx, completely obstructs the airway, and unless prompt treatment is applied the patient dies of asphyxia. Sometimes the obstruction is only partial, but there is marked respiratory distress, and treatment in these cases also must be prompt, as at any moment the obstruction may become complete. A dental plate is probably the commonest foreign body to become impacted in the pharynx, and owing to its irregular shape and relatively sharp edges it may present considerable difficulty in removal. The act of vomiting may be followed by laryngeal obstruction, the involuntary muscular movement either dislodging a dental plate or the vomited matter itself blocking the laryngeal opening.

Treatment must be immediate. The mouth should be forced widely open and the forefinger inserted into the pharynx, swept round the pharyngeal walls and any obstruction felt removed. Failing the detection or removal of the obstruction, if the patient is "in extremis," laryngotomy should be performed at once. If the symptoms are not too urgent and the instruments are available, direct laryngoscopy may be performed and the foreign body removed in this way.

(3) **In the Larynx.** A foreign body will enter the larynx only by inhalation, usually during a violent or deep inspiratory effort. This is usually of a semi-involuntary nature, as when some one is given an unexpected slap on the back while something is in the mouth.

Small foreign bodies, however, may become impacted external to the larynx, either in the vallecula or the pyriform fossa. These situations are really part of the deep pharynx, but the symptoms produced are referred almost entirely to the region of the larynx. Small pieces of bone or wire are met with most often, and they can be seen and diagnosed only by means of the laryngeal mirror. The patient complains of pain and choking immediately after a mouthful of food. This may be so severe as to induce constant coughing and hawking, and swallowing is extremely painful. The foreign body may be removed sometimes by indirect laryngoscopy, the patient holding his own tongue forward, thus leaving the surgeon with two hands free. The fragment is often comparatively firmly fixed, so that a good purchase must be obtained. Failing removal by indirect laryngoscopy, the foreign body readily can be removed by direct laryngoscopy. It is relatively uncommon to see a foreign substance impacted in the larynx and causing much obstruction to air entry, it usually being large enough to become fixed in the pharynx or small enough to pass into the trachea. In addition the laryngeal mucous membrane is so sensitive that violent spasmodic contraction results the moment a foreign body touches its surface, and the glottis is closed. Small foreign bodies sometimes become fixed in the ventricles, and by producing severe pain and spasmodic contraction give rise to what practically amounts to complete obstruction. If left in situ for any length of time, the presence of the foreign body may give rise to œdema of the glottis (*i.e.*, acute œdematous swelling of the laryngeal mucous membrane), and this will make the obstruction complete.

Œdema of the glottis may supervene very rapidly at any time while a foreign body is present in the larynx, and for this reason the case always should be treated as urgent, even if the symptoms do not at first appear to be very grave.

Treatment. It may be possible to remove the obstruction by indirect means with suitably curved forceps, but the use of the direct laryngoscope, either with or without an anæsthetic, is much the more satisfactory and easy operation. It should be rarely, if ever, necessary to open the larynx externally by thyrotomy if the direct laryngoscope is available.

(4) **In the Trachea.** To lodge in the trachea a foreign body must be small enough to pass between the cords, and large enough to prevent its dropping into one of the bronchi. It reaches the trachea by inhalation, and if of sufficient size and with jagged edges may become impacted anywhere down the

length of the trachea; usually it comes to rest at the bifurcation. The amount of respiratory obstruction produced depends on the shape and size of the foreign body, relative to the size of the trachea, but it may produce complete and instantaneous obstruction, in which case asphyxia is complete. The tracheal mucous membrane is very sensitive just below the glottis, but insensitive at the bifurcation, and for this reason an obstruction at the upper end of the trachea will produce pain and constant coughing, whereas at the lower end it may produce only slight dyspnœa or even no symptoms at all. Also the foreign body may alter its position with the movements of the patient's body or during coughing, sometimes causing violent expiratory spasms, and at other times giving no sign of its presence.

Symptoms. During the passage of the body through the larynx and upper trachea the patient suffers from a severe attack of coughing and dyspnœa, which may last some time. A little bloodstained froth may be expectorated and then the symptoms pass off. Whenever the patient's respiration becomes obstructed an attack of coughing is induced, and it may be possible to hear the fragment " rattling " in the trachea by applying a stethoscope to the neck. A constant asthmatic wheeze is frequently present, with increased rapidity of respiration. For some time (six to twelve hours) very little reaction may be produced in the tracheal mucous membrane, but sooner or later inflammation and ulceration will commence, with exudation; the symptoms become chronic and the obstruction gets more and more marked, and probably will become complete. If the foreign body is opaque to X-rays it can be seen readily by radiography.

Treatment consists in the introduction of the bronchoscope and removal by means of suitable forceps. The earlier this is done the better, as there will be less secretion and œdema, and therefore removal is much more easily accomplished.

If the foreign body is firmly impacted and it cannot be removed by ordinary peroral tracheoscopy, tracheotomy may be performed and an attempt made to remove it by passing the tube through the tracheal opening. If no instruments are available for the above operation and it is thought necessary to do something to relieve marked dyspnœa, tracheotomy may be performed and an attempt made to dislodge the body by means of any forceps available. It also has been recommended to stitch the tracheotomy wound open and hope for the body to be expelled during an attack of coughing. Where possible, however, the patient should be at once removed to a hospital where the necessary instruments are available, as any external incision considerably increases the danger to life.

(5) **In the Bronchus.** A foreign body may become impacted in the right or left bronchus or any of their branches and bifurcations, according to its size, the latter factor determining the distance it will travel down the air passages before being held up. The right bronchus is the more common direction for a foreign body to take, owing to this being slightly larger than the left one and in a more direct line with the trachea. Common articles found in the bronchi include pins and nails which have been held between the teeth while the patient is at work, pieces of teeth or fragments of dental plates, pieces of nut or almond, parts of tonsils following operation, small fragments of bone, toy whistles, and parts of children's toys. These are all inhaled directly into the trachea and drop into the bronchi. A series of symptoms similar to those described in relation to the trachea are first manifested; these are known as the first or immediate symptoms. These symptoms

soon pass off, and do not recur; indeed, they may be so slight as not to be noticed at all, and attention is only directed to the possible presence of a foreign body by the appearance of the secondary or late symptoms. Careful inquiry will then reveal a possible occasion when a foreign body might have been introduced into the lung. Even if obstruction is incomplete at first, it soon becomes complete owing to œdema of the bronchus in which the obstruction is lodged. If a right or left main bronchus is involved the whole of the affected lung becomes shut off from its supply of air, and according to the size or position of the bronchus or bronchiole involved, so much lung becomes collapsed. When the obstruction is complete or valvular, allowing expiration only, the air in the obstructed lung or lobe is absorbed (atelectasis), breath sounds are absent, and on radiography the affected lung will be seen collapsed, causing elevation of the diaphragm on the same side and displacement of the normal lung and heart towards it. On inspection movement will be seen to be diminished on the affected side, and this is, of course, more marked if the whole of one lung is involved. While the patient is at rest there may be very little evidence of dyspnœa.

In many of these cases there is an interval, which may extend into weeks, during which there are no symptoms and no suspicion is entertained of the presence of anything in the lung. The patient eventually develops a chronic cough with purulent and bloodstained expectoration going on to bronchiectasis, peri-bronchial pneumonia or lung abscess. A careful examination will reveal the above characteristics of a collapse of a portion of the lung.

In cases in which the foreign body introduced is composed of vegetable matter, such as nut or bone, the element of septic infection is much more marked, and the so-called late symptoms may commence within twenty-four hours, a free purulent expectoration with pyrexia being the most usual additional manifestation. If these symptoms have become established and the patient is left untreated, death usually supervenes from pneumonia or septic infection and exhaustion. In quite a number of cases the foreign body is expelled during a violent fit of coughing months, or even years, after its inhalation. Sometimes the lung abscess extends to the pleura, producing a localised empyema, from which the article is extruded when the abscess is opened externally.

Treatment. The foreign body can be removed almost always by means of the bronchoscope, and the earlier this instrument is used the better the operative prognosis. First of all, however, it is essential to localise the fragment by careful physical examination and the use of the X-rays. X-ray photographs of the bronchial tree after injection of lipiodol are useful (see p. 452). On bronchoscopy the division of the trachea into its two main bronchi can be seen, and the presence of any excessive secretion from one or the other should be noted. By means of tubes of suitable size the first main divisions of each bronchus can be examined, and it is possible to inspect the bronchi for at least two divisions beyond the main bronchus. If the bronchoscopy is carried out within twenty-four hours of the inhalation of the foreign body the bronchi usually appear quite normal, and the article can easily be withdrawn by suitable forceps. Owing to excessive secretion and œdema, it may be impossible on the first examination to do more than mop out a large quantity of foul mucopus, and this is frequently the case when the impacted body has been present for any length of time. A second examination twenty-four or forty-eight hours later may reveal the actual cause of the obstruction. It is advisable to give a general anæsthetic for the operation of bronchoscopy, at any rate for the first attempt. If the foreign body is so small that it has fallen into a bronchus too narrow for the introduction of a bronchoscope, it may be removed by direct incision into the bronchus across the pleura.

INJURIES TO THE LARYNX

The commonest injury met with in relation to the upper air passages is *cut throat* as the result of attempted homicide or suicide. This will be described on p. 395.

Fracture of the hyoid bone has been mentioned already. Œdema of the glottis may supervene on this condition, but this is unlikely, and if it occurs tracheotomy should be performed. The fracture should be reduced by external and internal manipulation, and the neck muscles rested subsequently. This may be attained by applying a light and immobilised plaster splint round the neck to prevent all movement of the cervical vertebræ. The patient should be forbidden to talk, and if deglutition is very painful or is followed by much reaction, a nasal feeding tube may have to be worn for two or three days. (See p. 394.)

The *thyroid cartilage* may be fractured or badly bruised as a result of direct violence applied to the thyroid region of the neck ; this will be followed by œdema and possibly the formation of a hæmatoma, either internally or externally. There may be severe pain, and there is danger of dyspnœa becoming acute as a result of œdema of the glottis. The patient, therefore, must be kept under careful observation for at least twenty-four hours, in case tracheotomy is required. Indirect laryngoscopy in such a case often will reveal a marked swelling and discoloration of one or both ventricular bands and vocal cords.

Ice-cold compresses should be applied to the neck to reduce swelling, and absolute rest should be ordered until all danger of acute symptoms arising has subsided.

INFLAMMATIONS OF THE LARYNX

Simple acute laryngitis is similar to an acute inflammation of the mucous membrane of any other part of the air passages. Exposure to cold air and lowered resistance predispose to its occurrence, and the inflammation may be primary in the larynx or may extend to the larynx from the nose, fauces or tonsils.

The symptoms consist of pain in the region of the larynx, especially on coughing or attempts at phonation, and a partial or complete aphonia. The airway feels very dry, and cough is absent until exudation takes place. The breathing sounds harsh and rough, while the cough is very painful. Slight fever will be present.

The treatment may be described as local and general. The patient should remain in a warm, well-ventilated room, and a purge should be administered. Absolute vocal rest should be insisted on during the acute painful stage, otherwise chronic laryngitis may result.

Cold compresses to the neck sometimes give relief, and in order to encourage the secretion of mucus as soon as possible, inhalations of steam from a jug containing half a pint of water at a temperature of 120° F., to which has been added a teaspoonful of compound tincture of benzoin or oil of creosote, should be ordered. An inhalation should be applied for five minutes every three hours.

Acute laryngitis occurring in children is more serious than in adults, and is much more likely to go on to œdematous laryngitis and dyspnœa. Any form of laryngitis or laryngismus stridulus is popularly known as croup in the case of children.

Chronic laryngitis may be described as a chronic inflammation of the mucous membrane of the larynx, the chief symptoms of which are alteration and impairment of the voice. The larynx is seldom the primary seat of inflammation, this being usually secondary to nasal catarrh, nasal obstruction or bronchitis. Chronic laryngitis is nearly always present in patients suffering from pulmonary tuberculosis. On examination with the laryngoscope the vocal cords sometimes appear normal, but usually they are dull or even pink in colour and thickened. Pellets of mucus are frequently seen, especially adherent to the interarytenoid space. The inflammation is bilateral, and any indication of its being unilateral should at once rouse the suspicion of local tuberculosis or malignant disease.

The treatment of chronic laryngitis depends on attention to the general health and to the condition of the nose, mouth and pharynx. When the principal cause is found to be in the larynx itself, it often will be discovered that it is due to faulty use of the voice.

Over-indulgence in smoking and alcohol are common causes of laryngitis.

When local treatment to the larynx is decided upon, a laryngeal spray may be used. In resistant cases astringents may be applied by means of the spray, silver nitrate (grs. ij—v, to the ounce of water), and zinc sulphate (grs. ii—x, to the ounce of water) being useful.

Singer's nodes or nodular laryngitis is a form of chronic laryngitis characterised by thickening of the vocal chords. On examination a small white nodule is seen on both cords at the free margins, usually at the junction of the anterior and middle thirds. These nodes are due to a thickening and heaping up of the stratified epithelium, resulting from chronic irritation produced by faulty voice production. If large in size, they should be removed by direct laryngoscopy.

Œdematous laryngitis means an acute œdematous infiltration of the tissues bounding the upper larynx, more especially the ary-epiglottic and interarytenoid region. The cords themselves are not actually affected owing to the fact that the stratified epithelium covering them is firmly bound down to the underlying elastic fibres.

It may be due to any of the following causes : impaction of foreign bodies, inhalation of boiling steam or hot liquids (in children especially), the drinking of corrosive fluids, as an extension of inflammation from surrounding tissues in the neck, from acute laryngitis, or as a result of rough instrumentation at the performance of an adjacent operation. The condition can be diagnosed easily by means of the indirect laryngoscope.

Treatment. Tracheotomy will be required in urgent cases, but the symptoms can often be relieved by scarification of the affected mucous membrane by means of a suitable knife and with indirect observation. Steam inhalations and adrenalin spray should be tried, and if the condition is accompanied by much secretion, relief will be gained from the administration of atropine subcutaneously. Ice compresses should be applied to the neck.

Pachydermia Laryngis. This is a condition in which there is a hyperplasia and thickening of the mucous membrane covering the posterior ends of the vocal cords and the interarytenoid space. The appearance seen with the laryngoscope is fairly characteristic, but a diagnosis has to be made from tuberculous or malignant disease. There is little or no impairment of movement of the cords, and the thickening is almost always bilateral and always confined to the posterior ends of the cords.

The etiology of pachydermia is unknown, but it is more common in men than women, usually between the ages of thirty and sixty. Excessive smoking and drinking of alcohol are said to predispose the patient to this affection.

The symptoms produced are weakness and impairment of the voice. The condition is very intractable to treatment, and endolaryngeal operative interference is contra-indicated.

Diphtheritic laryngitis is usually an extension of the affection from the fauces, in which case the condition should have been recognised in that situation. The formation of the diphtheritic membrane and the local inflammation gives rise to severe dyspnœa from obstruction of the airway, and if the condition does not yield rapidly to the injection of diphtheritic antitoxin (Vol. I., Ch. VI.), tracheotomy will be required and a tracheotomy tube inserted until the patient is able to breathe through the larynx once more. The patency of the airway can be tested at intervals by removing the inner tracheotomy tube, placing a finger over the entrance, and observing if the patient can breathe by means of the opening in the upper wall of the outer tube, an opening which is specially made for this purpose.

While the tracheotomy tube is worn great care must be taken to remove all expectorated secretion at once and particular care must be taken to keep the tube clear. There is always a danger of a fragment of membrane being inspired and forming a fresh focus of infection in the lung.

After the operation of tracheotomy the child should be given a tent and steam kettle with a special nurse to keep the tube clear. The metal tube should be replaced by a rubber one within from twenty-four or forty-eight hours to prevent ulceration of the trachea.

PARALYSES OF THE LARYNX

These are observed in a variety of laryngeal conditions, but the only ones of surgical interest are those which affect the inferior laryngeal nerve and are due to injury or pressure. One or both recurrent nerves may be involved, but the left is more commonly affected, owing to its longer course under the arch of the aorta rendering it much more liable to involvement by intrathoracic conditions. Not infrequently there is only a partial paralysis, and in that case it is invariably the abductor muscles which are affected, the adductor muscles remaining active, and the cord practically immobile in the position it occupies on phonation. In a case of complete paralysis of the nerve, the vocal cord on the affected side becomes absolutely immobile in what is known as the "cadaveric position," *i.e.*, midway between that in which it is placed during phonation and deep inspiration. If for any reason there is an abductor paralysis only, on both sides, no adequate airway is left between the cords, and an immediate tracheotomy will probably be required. Paralysis (complete) of one vocal cord may result in permanent impairment of the voice, but in many cases there is a transient aphonia, and subsequently phonation is carried out by over-action of the active cord. In the case of a unilateral abductor paralysis there will be no alteration in the voice, but dyspnœa may be noticed, especially on exertion. Paralysis of both nerves produces absolute aphonia.

Paralysis of the inferior laryngeal nerve can be diagnosed only by examination of the larynx by indirect laryngoscopy, and when this is carried out the exact state of affairs can at once be determined, the only condition from which it has to be distinguished being fixation of the cord due to local disease of the larynx. Examination of the action of the cords is, therefore, of considerable value as a means of diagnosing certain intrathoracic or deep cervical conditions.

The following are among the more common causes of inferior laryngeal nerve paralysis :—

1. *Direct injury* from a bullet wound in the neck severing the nerve partially or completely, or as a result of a surgical operation on the neck, more especially thyroidectomy.

Following a thyroidectomy, only the nerve on the same side as the lobe of the thyroid gland removed will be affected. Paralysis of the nerve in such a case may be transient, or may come on some weeks later owing to the nerve becoming involved in scar tissue.

2. *An aneurysm of the arch of the aorta* commonly causes sufficient pressure on the left inferior laryngeal nerve to give rise to partial or complete paralysis.

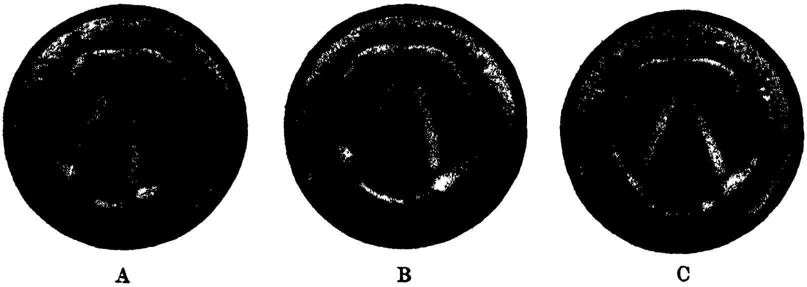


FIG. 130. (A) Deep inspiration with abductor paralysis of the left cord (indirect view). (B) Deep inspiration with complete paralysis of the left cord (indirect view). (C) Cords in the cadaveric position (indirect view).

3. *Tuberculous infection of the mediastinal lymphatic glands* may cause paralysis of either nerve, but much more commonly the left.

4. *Adhesions and inflammation of the pleura,* secondary to apical pulmonary tuberculosis, may involve either inferior laryngeal nerve.

5. *Malignant disease* in either—

(*a*) the œsophagus,
(*b*) the thyroid gland,
(*c*) the mediastinum or lung,

may involve first one and then both inferior laryngeal nerves. In the case of intrathoracic new growths the left nerve is much the more frequently involved.

6. *Dilatation of the heart,* especially of the left auricle, has occasionally produced it.

Functional aphonia or hysterical aphonia is most commonly seen in young girls, sometimes at as early an age as eight. The condition occurs in anæmic, nervous individuals, often as a result of some sudden emotion or shock. It is characterised by complete loss of the power of phonation, which may come on quite suddenly, and it has to be diagnosed from organic disease of the larynx. On examnatiion the larynx appears normal, but when the patient attempts to phonate it is seen that the cords do not approximate, or if they do so, it is only for a fraction of a second and then they immediately fly apart, no voice being produced.

If the patient is next told to cough gently, the cords will be seen to approximate normally. This settles the diagnosis.

Treatment is mainly suggestive, and the patient must be told that the condition is quite curable and systematic instruction as to treatment should be given. The general health must be attended to, especially if there is any neurasthenic tendency.

Tuberculous laryngitis is almost always secondary to pulmonary tuberculosis, even though no evidence of pulmonary disease can be detected The disease arises locally, owing to the constant exposure of the mucous membrane of the larynx to the sputum infected with the bacillus of tuberculosis. The disease most commonly commences in the arytenoid region, spreading into the interarytenoid space and posterior ends of the ventricular bands, but it may start in any part of the larynx, including the epiglottis. It commences as a submucous infiltration which eventually breaks down, forming the typical tuberculous ulcers as seen in other viscera. The submucous tissue becomes œdematous, and this is particularly noticeable over the arytenoid cartilages, where the swelling may be so marked as to obscure the lower part of the larynx from view. The anæmic, almost pearly, polypoid appearance of the swollen mucous membrane is an important early diagnostic sign. Considerable destruction of tissue eventually occurs, involving the whole circumference of the larynx and leading to necrosis of the cartilages.

Hoarseness is the first symptom complained of, and a cough is often present from the start. The aphonia becomes more marked as the disease advances. Once the epiglottis has become involved or the posterior surface of the arytenoid folds ulcerated, pain on swallowing may become a prominent symptom. This may be so severe as to force the patient to the verge of starvation, with resultant rapid progress of the disease to a fatal issue.

The condition has to be diagnosed from malignant and syphilitic disease of the larynx. It is in the early stages of the disease that diagnosis is the most difficult, but a small single ulcer should always arouse the suspicion of tuberculosis, and even hyperæmia of one cord as opposed to bilateral inflammation is strongly suggestive of tubercle. Malignant ulcers, while remaining localised, produce more fixation of the movable structures of the larynx. Pain is much more marked in laryngeal tuberculosis. In very chronic and localised ulceration it may be necessary to remove a portion of the diseased tissue for microscopy.

It is not uncommon in the later stages for a *tuberculous perichondritis* of the laryngeal cartilages to occur and give rise to caries and the formation of a cold abscess.

Treatment is mainly constitutional as for all tuberculous infections. Absolute silence must be insisted upon to ensure complete laryngeal rest. Local treatment is only worth trying if the disease is confined to a small area, in which case it may be either cauterised or excised. The earlier the condition is diagnosed the more likely will it be to yield to treatment. It must not be forgotten that about 75 per cent. of patients suffering from pulmonary tuberculosis have laryngeal symptoms at some time or another, without there being any local laryngeal infection with the tubercle bacillus. This is due to a chronic laryngitis which is set up as a result of the constant coughing.

Tuberculous perichondritis probably will require incision and curetting.

Lupus of the larynx may occur as a primary manifestation or as the result of extension from the pharynx. Clinically its appearance is the same as that seen in the pharyngeal mucosa, there being no infiltration of the deeper structures and pain being absent.

Typhoid disease of the larynx is occasionally seen. An ulceration of the mucous membrane due to this cause has been described, but is very rare. A less rare form of disease is typhoid caries and necrosis of the laryngeal cartilages, leading to the formation of a cold abscess.

Syphilitic disease of the larynx is usually seen as a secondary or tertiary manifestation. The mucous membrane shares in the general inflammation of the mouth and pharynx seen during the secondary stage, becoming dusky red in colour and sometimes producing pain and hoarseness. The typical "mucous patches" are often seen on the mucous membrane of the deep pharynx and epiglottis, but rarely occur in the larynx intrinsically. Tertiary disease usually takes the form of a circumscribed gummatous infiltration which gradually increases in size, fixes the surrounding structures and, if untreated, breaks down and gives rise to a deep tertiary ulcer. Another tertiary manifestation of syphilis is a diffuse infiltration of the epiglottis, vocal cords and interarytenoid fold.

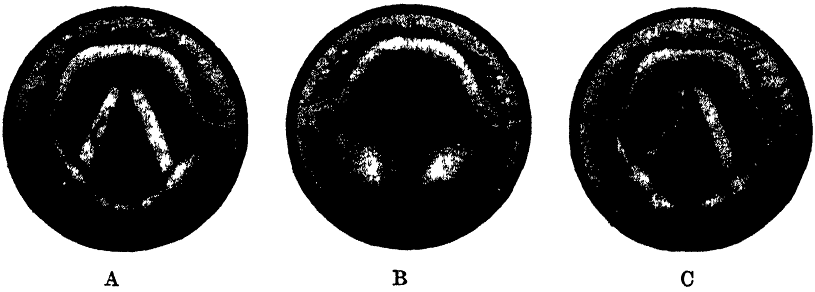

A B C

FIG. 131. (A) Fibrohæmangioma of the right cord. (B) Early tuberculous laryngitis. (C) Epithelioma of the right cord. These are all indirect views.

Either of these conditions may produce dyspnœa severe enough to require tracheotomy. Pain is not a prominent symptom unless there is ulceration of the epiglottis or posterior surface of the cricoid plate, but hoarseness will be noticeable if there is much swelling or ulceration within the larynx.

Diagnosis can be helped by inquiry into the history of a primary infection and the Wassermann reaction test. Tuberculosis of the larynx and malignant disease are the two conditions with which it is liable to be confused, and it must not be forgotten that a syphilitic patient may contract tuberculosis, and that malignant disease not uncommonly attacks patients who have had syphilis. Pain is a much more prominent symptom in tuberculous laryngitis, and the pearly grey œdematous appearance of the mucous membrane is characteristic.

General antisyphilitic treatment is required, but the healing sometimes produces extensive scarring and stenosis of the larynx requiring relief by permanent tracheotomy.

NEW GROWTHS OF THE LARYNX

Non-malignant new growths of the larynx. These consist mainly of simple tumours projecting from the mucous membrane of the larynx. All new growths met with elsewhere in the tissues of the body may have their counterpart in the larynx, but papillomata are the most frequent, fibromata and fibro-hæmangiomata coming next.

The cause of these benign growths is unknown; they are more common in males than females, and are usually diagnosed before the forty-fifth year.

Papillomata are much more commonly met with in children, the other forms being more common in adults.

Papillomata are the commonest simple new growths met with in the larynx and are composed of a connective tissue base, covered with a layer of epithelium exactly similar to papillomata elsewhere in the body. They may be single or multiple, sessile or pedunculated. Single growths usually occur on the anterior two-thirds of the vocal cords, but multiple growths may arise anywhere on the surface of the laryngeal mucous membrane. The younger the patient the greater is the tendency for the papillomata to be multiple. When the larynx is examined by laryngoscopy the typical white papillomatous warts are seen (Fig. 132), and if present in large numbers they may obscure the normal mucous membrane almost entirely from view.

Symptoms. A single papilloma on the margin of the vocal cord may cause complete aphonia, but several may be present elsewhere without giving rise to any symptoms. Multiple papillomata in children cause aphonia and sometimes severe dyspnœa and stridor, the latter calling for the performance of tracheotomy.

Diagnosis can be made only by laryngeal examination, and in children this will require the administration of a general anæsthetic.

Treatment consists in removal of the growth as completely as possible, and this is best carried out by means of the direct laryngoscope. Papillomata are very liable to recur, especially if multiple and in young children, and for this reason they may require repeated removal. They are said to tend to disappear spontaneously as the child grows older. In children with multiple growths the prognosis as regards life is bad, owing to recurrence, involvement of the tracheal mucous membrane by the papillomata, and the danger of pneumonia, etc., from inhalation of fragments of growth.

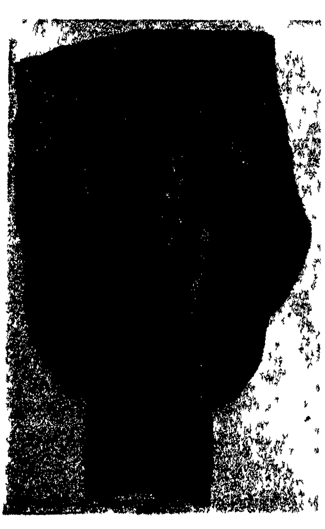


FIG. 132. Specimen showing multiple papillomata of the larynx in a young child.

Fibromata consist of fibrous connective tissue, are sometimes very vascular (fibro-hæmangioma), and are covered with a thin layer of epithelium. They are usually situated singly on the anterior two-thirds of the vocal cord, and may be sessile or so pedunculated that at times they hang down below the cord and cannot be seen. They vary in size from a hemp seed to a large pea.

Treatment is effected by removal by direct laryngoscopy. If the tumour is removed completely, there is little or no tendency to recurrence.

Malignant Disease of the Larynx. Malignant disease of the larynx is a disease of late adult life, the largest number of cases occurring between the ages of fifty and sixty. It has, however, been recorded as early as the age of twenty-five, and is more common in males than in females.

Pathology. Squamous-celled carcinoma is the usual variety, but sarcoma is occasionally met with.

Carcinoma of the larynx is almost always a primary lesion, but occasionally the larynx is involved by an extension of a growth from the thyroid gland, deep pharynx or base of the tongue. The disease is classified for clinical purposes into "intrinsic" cancer of the larynx and "extrinsic" cancer of the larynx.

"*Intrinsic*" *cancer* includes tumours originating in and confined to the ventricular bands, the ventricles of Morgagni, vocal cords, and the mucous membrane lining the larynx below the cords.

"*Extrinsic*" *cancer* is that involving the other structures forming the larynx, and occurs chiefly in the ary-epiglottidean region.

In more than half of all the cases of laryngeal cancer the growth commences on the vocal cord and is therefore squamous-celled in type. If starting in other situations it will be columnar-celled. As long as the growth remains confined to the vocal cord, or even as long as it is confined to the intrinsic tissues of the larynx, its increase in size is slow. A carcinoma may remain "intrinsic" for as long as two years.

Directly the growth has become extrinsic, its advance is rapid and glandular involvement, ulceration, dysphagia, etc., soon supervene.

The symptoms of laryngeal cancer in its early stages are vague, much the commonest being impairment of the voice; pain and dysphagia are only complained of when the disease is well advanced. A relatively very small growth on one cord may produce marked hoarseness, whereas extrinsic growths are often first noticed on account of the glandular involvement seen externally in the neck. It is of the greatest importance that the disease should be diagnosed early. If operative treatment is carried out while the growth is confined to the vocal cord the prospect of ultimate cure is better than that for carcinoma in any other part of the body. All cases of hoarseness persisting longer than two or three weeks, and occurring in patients over the age of forty, should be subjected to a careful examination of the larynx with a view to the possibility of carcinoma being present.

The symptoms of pain (shooting up to the ear), dysphagia, dyspnœa, fœtor, hæmorrhage, etc., only manifest themselves when the disease is well established and almost certainly beyond hope of a cure.

Diagnosis. Laryngeal cancer may be confounded with tuberculosis, syphilis, pachydermia and laryngeal palsy. Any one-sided inflammation of the larynx seen with the laryngoscope is suggestive of cancer, tubercle or syphilis.

It is often extremely difficult to distinguish a tuberculous ulcer of the vocal cord from a malignant growth, but malignant disease is much more likely to lead to early fixation of the affected cord. In doubtful cases a small piece may be removed for microscopical examination by means of the direct laryngoscope.

If there is any suggestion of syphilitic infection, the Wassermann serum test should be performed.

Prognosis. Untreated malignant disease of the larynx inevitably leads to death in from one to two years. Slow-growing epitheliomata occasionally extend over several years.

Treatment. The only treatment practicable with a view to radical cure is excision of the tumour together with a surrounding area of healthy tissue, on the lines laid down for the surgical treatment of malignant disease elsewhere in the body. As has already been stated, the prospect of permanent cure is extremely good in intrinsic affections. Various operations have been described for this purpose, but the only two we will consider are—

1. The operation known as "Laryngofissure," which is a satisfactory method of dealing with epitheliomata confined to one cord, and in which class are included the vast majority of cases in which the prospect of a cure is really good.
2. Total "Laryngectomy," a severe operation which has been employed successfully in various more extensive malignant growths of the larynx.
3. Radium needles, introduced into the larynx (without puncturing the laryngeal mucosa) through a window cut in the thyroid cartilage, have been used with success ; each needle contains ·5 or 1 mg. radium element, and they are left in situ for seven to ten days.

OPERATIONS ON THE LARYNX

Laryngofissure or Thyrotomy. This operation can be carried out under local anæsthesia, but in this country a general anæsthetic is employed, and the most successful results have been obtained with chloroform. Chloroform produces less reactionary secretion in the lungs after operation and less respiratory movement during the operation, two important factors in connection with any surgical procedure in the air passages.

It is of the utmost importance that the mouth should be rendered as aseptic as possible before operation.

The patient is placed in the same position as for the performance of tracheotomy, and an incision is made in the midline extending from the hyoid bone to the sternal notch. The incision is carried down until the front of the thyroid cartilage, cricoid cartilage and trachea is laid quite bare. The thyroid isthmus is divided and tracheotomy performed, the anæsthetic being administered through the tracheotomy tube for the rest of the operation. The thyroid cartilage is now divided exactly in the midline; it may be ossified, when special shears will be required. The cricothyroid and thyrohyoid membranes will require partially dividing in the midline, in order to facilitate retraction of the thyroid alæ by retractors. The vocal cords are now seen in their entirety, and the surgeon should at once shut off the trachea, by means of a gauze plug packed round the convexity of the tracheotomy tube, from the thyroid incision. The mucosa of the larynx should be swabbed with 5 per cent. solution of cocaine in adrenalin to numb sensation and prevent coughing.

The inner perichondrium of the thyroid ala of the affected side is stripped up from in front with an elevator, so that the intrinsic muscles, etc., on that side are quite separate from the cartilage. The whole of this fleshy mass is then removed by means of scissors of the Mayo type half an inch clear of the growth and including the cartilaginous vocal process of the arytenoid posteriorly. Many surgeons advocate the removal of the thyroid ala at this stage together with the cord (*i.e.*, without the perichondrial detachment), but in any case the main part of the arytenoid cartilage must be left.

All bleeding points must be arrested very carefully and the packing removed. The alæ are allowed to fall together, and catgut sutures are applied through the perichondrium, etc., externally. The skin wound is closed, but the tracheotomy tube should be left in for twenty-four hours and then removed. After-treatment is much the same as in the case of tracheotomy. Sips of water may be given in twelve hours, and if swallowing is satisfactory fluid or semisolid nourishment may be administered right away.

In nearly all cases a fair voice is left, a new cicatricial cord developing which closely resembles the normal cord except that it is immobile.

Total Laryngectomy. Intratracheal ether or chloroform anæsthesia is generally employed, but the operation can be carried out under a local anæsthetic. The preliminary steps are the same as for laryngofissure up to and including the insertion of the tracheotomy tube, except that there is an additional transverse incision along the lower border of the hyoid bone. The trachea and larynx are freed carefully from the muscles, etc., on either side as far round as the œsophagus, and inferiorly to the fourth or fifth tracheal ring. The trachea is cut through just below the cricoid cartilage, separated from the œsophagus from above downwards, pulled forwards, and stitched to the skin at the lower end of the skin incision by means of strong catgut sutures. The intratracheal tube, of course, will have to be removed, and now the anæsthetic can be carried on directly into the tracheal opening. The larynx is tilted upwards and dissected off the œsophagus and pharyngeal constrictor muscles. The thyrohyoid membrane is divided with the ary-epiglottic folds and the larynx is removed, leaving behind the tips of the thyroid cornua. The opening into the pharynx is carefully sutured, the mucous membrane being inverted. Over this layer of sutures a further strengthening layer is required, bringing together the walls of the pharynx, the muscles and fasciæ, so as to build up a wall of resistance to the strain of the act of swallowing.

The external wound is then closed down to the level of the opening into the trachea. A nasal feeding tube should be inserted, and retained in position for at least a fortnight. After-treatment is otherwise the same as for tracheotomy, but care should be taken to keep the wound as clean as possible, particularly to prevent any discharge from running down into the trachea, which forms an unprotected receptacle.

Various difficulties and modifications of this operation have been described, and will be found in text-books on operative surgery. The question of excision of infected glands in the neck often will have to be considered.

The operation has met with a large degree of success in recent years, and in many cases the patients subsequently lead quite reasonable and healthy lives. An artificial larynx can be fitted to produce some tone in the voice, but many cases are on record where the patients can speak in quite a loud whisper without any aids.

Hemilaryngectomy is an operation which is very seldom performed nowadays. If laryngectomy is not performed, some partial operation with introduction of radium needles is the more general method.

OPERATIONS FOR OPENING THE AIR PASSAGES BEYOND THE FAUCES

1. The pharynx may be opened either by the operation of transhyoid pharyngotomy or lateral pharyngotomy.

(*a*) **Transhyoid Pharyngotomy.** An incision is made from the symphysis menti down to the upper margin of the thyroid cartilage in the midline. The hyoid bone is divided and the pharynx opened above or below it, or through the length of the wound. A good view is obtained of the back of the tongue, epiglottis and posterior wall of the pharynx.

(*b*) **Lateral Pharyngotomy** is performed through an incision along the anterior border of the sternomastoid muscle. The muscle, together with the carotid sheath, is retracted outwards and backwards, and the dissection is carried down to the lateral wall of the pharynx, just above the superior cornu of the thyroid cartilage. The superior laryngeal and superior thyroid vessels may be divided and, if necessary, the superior laryngeal nerve also. The inferior constrictor is incised with a vertical incision and the pharynx opened. A fair-sized portion of the wall of the pharynx may be removed by means of this exposure. The cut edges of the pharyngeal wall must be sutured very carefully and reinforced with sutures through the muscles lying over it. Both the above operations may be performed under a general anæsthetic given by means of an intratracheal catheter under slight positive pressure or after a preliminary tracheotomy. It is essential before performing these operations, or indeed any extensive operation on the pharynx, larynx or œsophagus, to clear up all septic foci in the mouth. Any teeth under suspicion as regards pyorrhœa should be removed, and septic tonsils or infected nasal sinuses also must be dealt with. For at least a week after the operation all food should be in liquid form, and given by a rubber tube passed through the nose at the time of the operation down to the stomach, and retained in position until normal deglutition can be attempted. By this means muscular efforts are avoided which otherwise would tend to tear open the sutures in the pharyngeal wall.

2. **Thyrotomy** is an operation for opening the larynx, and is described on p. 378.

3. **Laryngotomy** is an operation of urgency, but it is useful in certain cases. It should not be performed on children owing to the danger of injuring the internal tissues of the larynx. A vertical incision is made through the skin in the midline,

the edges rapidly freed and retracted, and the cricothyroid membrane divided horizontally. It may be necessary to ligature the cricothyroid artery, which arises from the superior thyroid artery and pierces the membrane. The operation also may be carried out in cases of great emergency by making a direct horizontal incision straight through skin and membrane. The only indication for this operation is that it can be performed more rapidly and easily than tracheotomy. There is less danger of fatal cellulitis of the neck following laryngotomy than is the case with tracheotomy, but there is more danger of stenosis of the airway as a result of endolaryngeal scar formation, and there is more likelihood of phonation being permanently impaired. The latter complication is all the more liable to occur if it is necessary for the patient to retain a laryngotomy tube for some hours or days after the operation, as in laryngeal obstruction in diphtheria, and therefore in diphtheritic cases tracheotomy should always be performed. Owing to the fact that the subglottic laryngeal mucous membrane is more sensitive than that in the trachea, a laryngotomy tube gives rise to more irritation than a tracheotomy tube. The operation of laryngotomy should be confined therefore to cases of emergency.

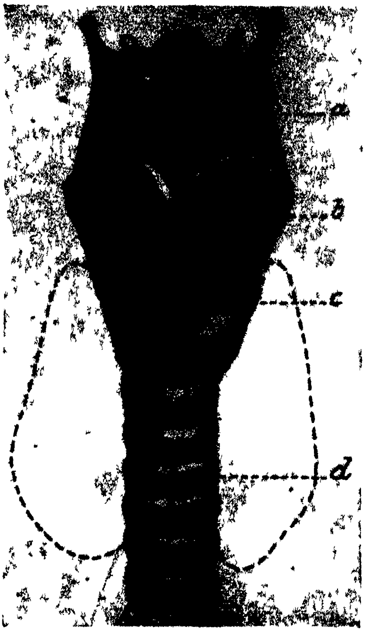


Fig. 133. Diagram showing incisions for opening the air passages. (*a*) Subhyoid pharyngotomy. (*b*) Thyrotomy (laryngofissure). (*c*) Laryngotomy. (*d*) Tracheotomy.

The operations of cricotomy or laryngotracheotomy should never be performed.

4. **Tracheotomy.** The difficulty of performing this operation varies with different individuals, being most marked in short-necked, fat patients. The trachea usually consists of from fifteen to twenty rings of cartilage, of which six or seven are above the sternum. The isthmus of the thyroid gland covers the third and fourth rings. Until recent years two distinct operations have been described for opening the trachea, high tracheotomy and low tracheotomy, according to whether the trachea is opened above or below the thyroid isthmus. This division is really quite unnecessary as it depends on whether the airway is opened above or below the isthmus of the thyroid gland. The thyroid isthmus may be divided easily and therefore no differentiation is required.

Tracheotomy is required in any condition in which there is serious or dangerous obstruction to respiration (except when it is due entirely to intrathoracic pressure), such as the presence of a foreign body, acute œdema of the larynx causing obstruction, severe laryngitis in diphtheria, intralaryngeal growths causing obstruction, pressure on the upper part of the trachea from malignant tumours of the neck, tuberculous laryngitis, if causing marked obstruction, and for some forms of laryngeal paralysis. It is also undertaken as a preliminary measure in many operations on the mouth, tongue, larynx or pharynx, although the intratracheal method of administration of general anæsthesia has superseded it in many cases. In these operations tracheotomy presents the advantage that the trachea can be packed off round the tracheotomy tube, and septic matter or blood can be prevented from finding its way into the lungs.

The administration of an anæsthetic depends on the urgency of the indications for the operation, and it may be necessary to perform tracheotomy without any anæsthetic, the patient being unconscious owing to cyanosis. A satisfactory method is to perform tracheotomy under local anæsthesia, this being due chiefly to the fact that the usual indication for the operation is obstruction to the airway, and when this symptom is present additional danger attends the administration of a general anæsthetic.

In order to perform the operation the patient should be placed flat on his back with a small pillow beneath the shoulders. The head should rest on the flat of the table, and it is of the greatest importance that it should be held and fixed with the point of the chin, pomum Adami, and supra-sternal notch in a straight line during the whole time of the opening of the trachea. If possible, one assistant should be told off for this purpose, while a child's head may be held in a special retaining apparatus (see p. 383).

An incision is made in the midline downwards from the upper border of the cricoid cartilage for not less than 2 inches.

The superficial fascia is divided in a vertical direction and the lower border of the cricoid cartilage defined.

The fascia just below the cricoid is then divided transversely until the first ring of the trachea is reached.' The closed blades of a pair of hæmostatic forceps are then passed downwards along the front of the trachea and behind the isthmus of the thyroid for about 1 inch. The forceps are then withdrawn, opened and one blade passed down behind and the other in front of the pretracheal fascia and thyroid isthmus which have been freed.

Another hæmostat is applied in the same way, both are closed and the tissues divided in the midline (see Fig. 136).

The upper four or five tracheal rings are thus exposed. The tissues clamped by the hæmostats may now be ligatured or this may be left till after the introduction of the tracheotomy tube.

The trachea is opened by inserting the point of a scalpel in the midline and making the cut upwards through two rings, preferably the fourth and third. In elderly patients some force will be required as the cartilaginous rings become partly ossified.

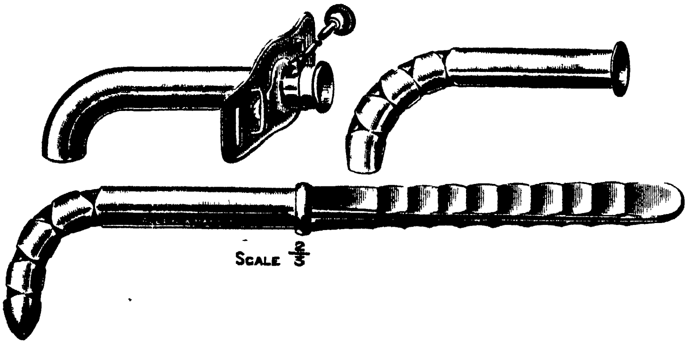


FIG. 134. Durham's lobster-tailed tracheotomy tubes—outer and inner, and introducer.

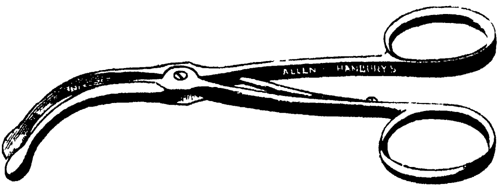


FIG. 135. Tracheal dilator.

If a tracheal dilator is used it should be introduced the moment the airway is opened and its introduction will be followed by the patient inspiring deeply and coughing for a few moments.

As soon as the coughing has subsided the surgeon should cut away the edges of the tracheal incision on each side so as to make the opening oval in shape. This can be done by seizing the cartilage at the edge of the wound with strong fine forceps and cutting with a sharp knife or small curved scissors. Even if the opening is only to be a temporary one the cutting open of the tracheal aperture should be carried out as it will in no way retard the eventual rapid healing of the wound in the neck.

The tracheal opening being satisfactory the tracheotomy tube (see Fig. 134) is inserted and tied into position by a tape passed round the neck. The skin edges may then be approximated, but the only dressing required is gauze packed round the metal tube to protect the skin and the margins of the wound.

If a tracheotomy is urgently indicated in an infant or child suffering from an acute obstruction it will not be possible to operate with the deliberation outlined above. In the event of an immediate operation being required the child should be placed in the usual tracheotomy position, a rather longer skin incision is made, the deep fascia is rapidly divided (bleeding being ignored), the trachea opened with a knife, and the blade of the knife twisted to force apart the cut tracheal rings. As soon as normal breathing has recommenced a blunt instrument can be forced in to maintain the opening until a tracheotomy tube is available.

Bleeding, which may appear very free, will cease usually when the trachea is opened, while in small children the large thymus gland will rise up into the neck, and may be a cause of difficulty when exposing the trachea.

The three important facts to remember in performing the operation of tracheotomy are :—

1. Avoid a general anæsthetic where possible, owing to the danger of the cessation of breathing occurring during its administration.
2. Keep rigidly to the midline with all cuts made by the scalpel.
3. The hæmorrhage must be controlled as carefully as possible. All bleeding points should be picked up with artery forceps and ligatured before the trachea is opened. It is not always possible to apply the ligatures owing to the urgency of the case, and it should be remembered that a good deal of the hæmorrhage is due to venous congestion, and will cease as soon as regular quiet breathing commences, *i.e.*, after the trachea is opened and coughing is over. Blood trickling into the trachea is very likely to cause pneumonia to supervene at a later date, and the danger of this is reduced to a minimum if the wound is kept dry.

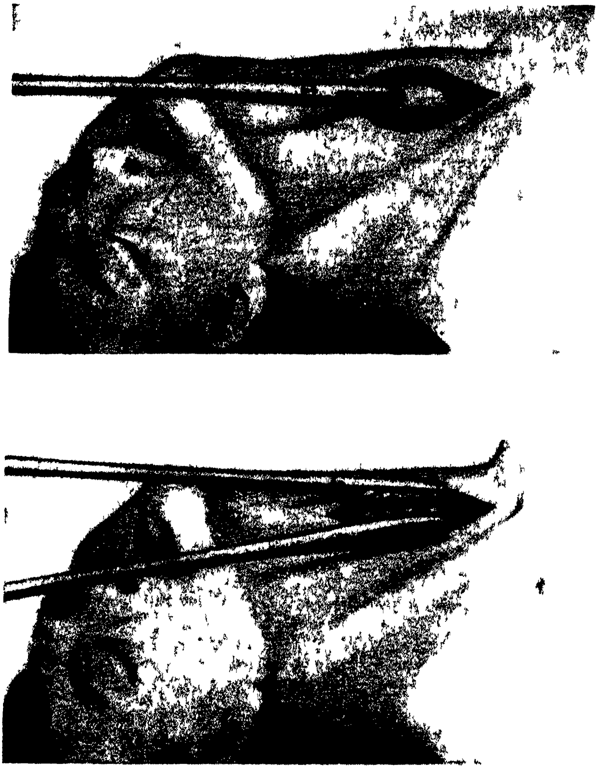


FIG. 136. Tracheotomy. Exposure of the trachea by division of the thyroid isthmus.

Several varieties of tracheotomy tubes are made, the only essential resemblance being that each consists of two elements, an inner and outer tube, the inner tube made so that it can be removed readily for the purposes of cleansing. When performing the operation of tracheotomy it is as well to have two or three different sizes handy, unless the patient is an adult. For cases in which tracheotomy is performed as a preliminary to some operation higher up in the respiratory tract special tracheotomy tubes have been designed, with tampons or sponges attached, which swell up and occlude the trachea above the tracheal opening. The disadvantage of this is that it is difficult to be sure of the amount of distension occurring, and considerable expansile pressure may be exerted on the walls of the trachea as a result.

After-treatment. The patient is placed in bed with extra pillows under the back, shoulders, and head, so that he is in a semi-sitting position. The room should be kept warm and draughts avoided, and at the same time the air should be moistened by steam issuing from one or more bronchitis kettles, so as to make up for the absence of nasal or oral breathing. Nothing should be placed over the entrance tube, and all expectorated mucus or false membrane should be removed by a nurse the moment it is expelled. It is extremely important that the tube and its surrounding gauze should be kept as clean as possible, and a constant watch must be kept on the tapes attached to the tube in order to prevent irritation of the skin round the wound, from rubbing. The inner portion of the tube should be removed and thoroughly cleaned by the nurse every six hours. The outer tube should be removed once a day, cleaned, and the track of the wound swabbed clean with dry gauze; this should be done by the medical attendant, and with the patient's head fixed in the extended position if necessary in the *Stockwell frame*, owing to the danger of difficulty being experienced in reinserting the tube.

The period for which a tracheotomy tube is worn varies in different circumstances. In cases of diphtheria it is retained only as long as the patient suffers from laryngeal obstruction, and it should be dispensed with the moment the patient is able to breathe freely through the mouth. After a metal tracheotomy tube has been in position forty-eight hours, a track is usually formed directly into the trachea which is sufficiently patent to allow of a rubber tube being used instead of the metal one. A rubber tube is more comfortable and less liable to cause ulceration of the trachea, and should replace the metal tube as soon as possible, but the disadvantages of it are that the end projecting into the trachea may be nipped by the cartilaginous rings and obstructed in this way, and also that the rubber tubes have no inner tube; they therefore should not be applied when there is much expectoration or danger of the tube becoming blocked. Tracheotomy tubes are made with an opening on the upper surface so as to allow laryngeal breathing at the same time as the tracheotomy tube is utilised, and by this means patients undergoing a temporary tracheotomy are encouraged to start normal breathing as soon as possible. If the tracheotomy is performed as a permanent measure, or if the tube has to be worn for any reason over a long period, the patient can be taught to change it himself once a definite track is formed and the tube slips easily into the trachea. Measures should be taken to prevent the formation of sores beneath the tapes, and these are avoided by keeping the wound clean and the surrounding skin dry. The patient must be impressed with the knowledge that the tube always must be kept in position, as even if it is left out for a few hours considerable difficulty may be experienced in replacing it. After a permanent tracheotomy tube has been worn for a few weeks, the wound should be almost healed and the tube fit snugly in place. The patient then requires very little in the matter of dressing beyond a small piece of gauze wrapped round the tube, the gauze being changed when it gets soaked. A special collar may be worn or a cage over the skin, to prevent the clothes from pressing on the mouth of the tube and causing obstruction to breathing.

After-complications of Tracheotomy. Several contingencies must be guarded against and watched for following the insertion of a tracheotomy tube.

1. The metal tube, if incorrectly shaped, may cause ulceration of the trachea on the posterior wall if it is too straight, and on the anterior wall if too curved. This ulceration may give rise to serious kinking or stenosis of the trachea when healing commences, and is best guarded against by making use of a rubber tube as early as possible.

2. Immediately following the operation the neck must be examined daily for the possibility of a localised collection of pus or a spreading cellulitis along the fascial planes of the neck.

In cases of diphtheria the wound may become locally infected with the disease.

3. Inflammation of the trachea, bronchi or lungs may occur, or the inspiration of blood or septic material may give rise to pneumonia. This should be watched for and every measure possible taken to guard against its occurrence.

4. Difficulty may be experienced in reintroducing the outer tube when it is

changed. If this arises the surgeon should not poke about blindly, but, using frontal illumination, should replace the tube under direct observation of the depths of the track.

5. Patients always should be warned against the danger of water getting into the tube.

Intubation of the Larynx means relieving the obstructed laryngeal airway by the introduction of a specially-shaped metal tube, which is left in position until the inflamed condition has subsided. A special introducer is required and the whole technique of the operation is more difficult than the operation of tracheotomy. O'Dwyer's tubes or some modification of his pattern are the usual variety made use of. The tubes are flattened from side to side and have an expanded upper end, which prevents them slipping through between the vocal cords into the trachea.

Drowning and Diseases of the Intrathoracic Portion of the Bronchi. These conditions are described in Chapter XI., pp. 436, 452 and 463.

CHAPTER X

THE NECK AND THYROID GLAND

Surgical Anatomy. Certain important structures will be found lying in the middle line of the neck. These are in order from above downwards :—

(1) The hyoid bone, which is opposite the third cervical vertebra.

(2) The thyroid cartilage; these two structures being connected together by the thyrohyoid membrane, upon which lies the subhyoid bursa. The bursa runs up behind the lower portion of the body of the hyoid bone.

(3) The cricothyroid membrane.

(4) The cricoid cartilage. This lies opposite the intervertebral disc between the fifth and sixth cervical vertebræ, and marks the junction both of the pharynx with the œsophagus and of the larynx with the trachea. Other important points at the same level as the cricoid cartilage are the carotid tubercle on the sixth cervical vertebra, the middle cervical ganglion of the sympathetic, and the point where the omohyoid muscle crosses the carotid vessels.

(5) Below the cricoid cartilage, when the head is extended, six or seven rings of the trachea may sometimes be palpated above the sternal notch. The second, third and fourth rings are crossed and covered by the isthmus of the thyroid gland. The upper part of the trachea is immediately under the skin, but the lower portion gets deeper and deeper until at the sternal notch it lies about one inch from the skin. In front of the trachea at this point lie the inferior thyroid plexus of veins, the thyroidea ima artery and certain veins connecting the two anterior jugular veins. In children under 2½ years of age the thymus gland may be found to be lying up above the sternum in front of the trachea in this situation.

The *cervical fascia* plays an important part in the surgery of the neck. It is a thick layer of connective tissue, completely surrounding the neck, which splits in front and behind to enclose both sides of the trapezius and sternomastoid muscles. Below it is attached to the clavicles and sternum, while above it is inserted into the base of the skull, the zygoma and the lower border of the lower jaw. It sends two strong partitions right across the neck, the prevertebral and pretracheal layers, which divide the neck into three main compartments. The posterior compartment contains the vertebral column, the prevertebral muscles, and the posterior spinal muscles. This compartment is limited by the base of the skull above, while downwards it passes uninterruptedly into the posterior mediastinum. The middle compartment between the prevertebral and pretracheal fascial layers contains the thyroid gland, the larynx, the trachea, the pharynx and œsophagus, while at the sides the fascia surrounds the carotid vessels to form the long tubular carotid sheath. This compartment passes down into the anterior mediastinum, while laterally it is continuous, along the subclavian vessels, with the axilla. The anterior compartment in front of the pretracheal layer contains the sternomastoid, the sternohyoid and thyrohyoid muscles; this only extends downwards as far as the sternum and clavicles and is limited above by the hyoid bone. Just above the sternum the fascia splits into two layers to enclose the space of Burns.

Cellulitis and infective conditions in the neck may have their direction of spread largely modified by these layers of fascia, while its distribution serves to explain the ease with which infection may pass from the neck to the mediastinum or axilla, or in the opposite direction.

Certain points in the development of the neck are important. In the third week of intrauterine life a series of arches, four or five in number, appear in the postoral region of the neck, and these arches are separated from each other by depressions known as the *branchial clefts.* These arches are lined on either side by epithelium, and they rapidly unite across the middle line and also with each other, so that the clefts between them are usually obliterated except in certain special situations. If this obliteration is incomplete, various malformations of the neck may result. The structures that arise from the various arches and clefts are important :—

From the first arch arise the mandible and part of the malleus, the symphysis menti, the mandibular division of the fifth nerve, and the muscles of mastication.

From the first cleft, the external auditory meatus, the tympanic cavity, the Eustachian tube and Glaserian fissure.

From the second arch, the lesser cornu of the hyoid, the styloid process, the stylohyoid ligament, the stapes, the seventh nerve and the muscles supplied by it. The second and third clefts usually completely disappear, though they are partly represented by the lateral pharyngeal recess, the fossa of Rosenmuller and the sinus pyriformis respectively; while from the third arch arise the body and great cornu of the hyoid bone, part of the internal carotid, the ninth nerve and the muscles it supplies.

The fourth and fifth arches give rise to the upper and lower parts of the thyroid cartilages, the superior and inferior laryngeal branches of the vagus and the muscles they supply, while the fourth cleft is represented by the ventricle of the larynx.

Malformations and Deformities of the Neck. Various malformations of the neck are found, which are chiefly caused by imperfect development or lack of fusion of the branchial arches and clefts; others are connected with the diverticulum which gives rise to the thymus and thyroid glands.

Pharyngeal Pouch. This is a diverticulum of the pharynx whose opening is always at the lowest part of the pharynx behind the cricoid cartilage, and the pouch bulges out below the bottom part of the inferior constrictor muscle. The condition is probably congenital at the beginning, but the pouch is continually increasing in size from the pressure of food, and usually passes down behind the left side of the œsophagus. The diagnosis, symptoms and treatment are described on p. 354.

Branchial Fistula (Lateral Fistula of the Neck). These fistulæ are thought to be due to imperfect obliteration of one or other of the branchial clefts, usually the third, though they may take origin possibly from the diverticulum which grows from the pharyngeal portion of the third cleft to form the thymus gland (Wegloski). Such a fistula may be complete in the sense that it passes from the surface of the skin into the pharynx, in which case its internal opening is usually found close to the tonsil (rather behind and below it), and the fistula will pass out behind the hypoglossal nerve, between the internal and the external carotids, along the sternomastoid to open on the skin over the lower third of this muscle near its anterior border, and just above the suprasternal notch. The more common form, however, is an incomplete external fistula running inwards from the skin for an inch or two. Such a fistula is lined with a ciliated columnar epithelium, and forms a narrow track secreting a mucoid fluid. If it is complete, particles of food may escape down the track, but it is seldom possible to pass a probe along it; its course may be recognised by injecting an emulsion of bismuth and taking an X-ray photograph. The fistula may be present at birth or may appear later as a result of rupture of a branchial cyst (q.v.). Not uncommonly other abnormalities, such as facial cleft, macrostoma, deformities of the pinna or accessory auricles, will also be present. An accessory auricle is often seen close to the opening of a branchial fistula. There is considerable evidence that rarely a form of carcinoma may arise in a branchial fistula (see p. 403) or cyst.

Treatment. Many cases require no treatment, though the discharge may be troublesome. If necessary an attempt should be made to dissect out the whole fistula, but this will be a difficult operation. In other cases an effort may be made to cauterise or scrape away the lining membrane, but this is rarely successful, and a sinus usually persists unless the curettage is followed by ionisation with zinc salts, when healing nearly always occurs. In the case of a complete fistula, the lower part may be dissected free and a fine bougie passed up it into the pharynx. This bougie and the lower end of the fistula in which it is are tied tightly together by a ligature. The part of the bougie projecting into the pharynx is then pulled up and the wall of the fistula is inverted into the pharynx, tied and cut off.

Branchial Cysts (see p. 400).

Accessory Auricles. Cervical auricles are seen down the side of the neck, usually along the anterior border of the sternomastoid muscle. They consist of small projecting pieces of cartilage covered by skin, which are derived from the second arch and may be associated with a branchial fistula close by. They cause disfigurement and discomfort and are better removed.

Thyroglossal Cysts (see p. 401).

Thyroglossal Fistula (Median Fistula of the Neck). This condition arises as the result of the persistence of the tubular downgrowth from which the central portion of the thyroid gland is developed, and the fistula is usually the result of a rupture of a thyroglossal cyst (see p. 401) which has become infected and inflamed and progressed to abscess formation or has been incompletely removed by operation. The condition causes a small amount of viscid discharge, and the opening is in the middle line of the neck or slightly to the left side, close to and often attached to the hyoid bone. If the whole length of the thyroglossal duct is patent the fistula may be complete, and it will then run from the skin to the foramen cæcum of the tongue. In this case it usually passes through the substance of the hyoid bone, occasionally in front of it. The lower part of such a fistula is lined with columnar epithelium, and the upper part by squamous epithelium similar to that of the tongue. Such a fistula usually appears in childhood between the ages of three and ten.

Treatment. The fistula should be excised. This may be a difficult and troublesome dissection, involving splitting the hyoid bone and, in some cases, dissecting down to the base of the tongue. Should a portion of the fistulous track be left behind inadvertently, the fistula is certain to recur. The track may be followed more easily if a preliminary injection of methylene blue is made into it. Sistrunk's method of removal consists in dissecting the fistula up to the hyoid bone, removing about a third of an inch of the centre of this bone. The duct with a tube of muscle and tissues round it is then removed right up to the foramen caecum if necessary.

Cervical Rib. A cervical rib is an extra rib which usually grows in connection with the seventh cervical vertebra, rarely with the sixth. It is articulated with its vertebra in most cases in two places in a way exactly similar to that in which an ordinary rib articulates. This condition is usually bilateral, is much more common in women than men, and is not generally noticed until after the age of puberty. At first the rib is mostly cartilaginous, but later in life it becomes ossified, as do the other ribs. This extra rib may project straight out from the transverse process of the vertebra and terminate in a free end, in which case probably it will cause no symptoms, as it will not press upon important structures, but in most cases it passes downwards and forwards and unites with the true first rib near the scalene tubercle, or sometimes with the sternum, by means of a costal cartilage. In other cases it is not actually in contact with the first rib, but is joined to it by a stiff band of fibrous tissue. Some of the scalene muscles may be attached to it, and the subclavian artery and the lower and inner portions of the brachial plexus will pass over it and may be displaced and hooked up by it. The condition does not give rise to any symptoms, as a rule, until after the age of eighteen. This delay in the onset of symptoms is partly due to the slight descent of the pectoral girdle which may occur at this time, and also to the fact that as ossification proceeds in the rib more and more disturbance is likely to be produced upon surrounding structures. The condition is often discovered accidentally in the course of a routine examination. The symptoms it produces are of two kinds, and are caused by pressure either on the artery or on the brachial plexus, the shorter ribs being most likely to produce pressure on the plexus, while the longer ones usually implicate the artery. The rib itself often may be felt, while the subclavian vessels are pushed upwards and forwards so that their pulsation is easily visible and palpable; this has at times been mistaken for an aneurysm, the more so as there is often a systolic bruit (see Vol. I., Ch. X.). The pulse on the affected side may be more feeble than on the other side when the arm hangs down, but this is not so noticeable when the arm is elevated, while the hand will be cold, blue and even œdematous ; on occasions, gangrene of the finger tips has been observed ; this usually starts in the index finger and on the right side. In a few severe cases no pulse can be felt from about the middle of the brachial artery downwards. This is almost always a sympathetic effect but may be due to direct pressure on the subclavian artery. In some instances the patient's chief complaint is of a general clumsiness of the arm and hand, while in others the pain is felt mainly in the upper arm and shoulder.

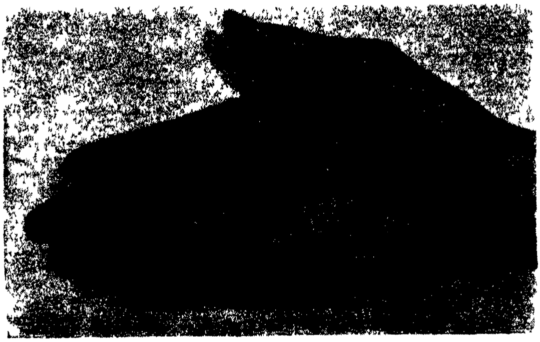


FIG. 137. Wasting of all the muscles of the hand due to the pressure of a cervical rib.

The other group of symptoms (of which the patient chiefly complains) are nervous symptoms, both sensory and motor, due to pressure on the brachial plexus, and are referable to the first dorsal and eighth cervical nerve roots. This gives rise to severe neuralgic pain, with tingling, numbness and sensations of coldness along the inner (ulnar) border of the arm, forearm and hand, and shooting up into the shoulder and neck, combined with weakness and wasting of the intrinsic muscles of both sides of the hand, especially noticeable in those of the thumb. The whole arm is cold and weak, and may have anæsthetic patches on it, while the symptoms are made worse by carrying weights, wearing heavy clothes, or work, and are relieved by raising the arm, and by rest. Patients at times always sleep with their arms above their heads. In some cases it is difficult to decide whether vascular or nervous pressure is the chief cause of the symptoms, for the general wasting of the hand in some instances will be due to a poor blood supply, and in other instances it is quite likely that gangrene of the finger tips is due to nervous influences ; it is quite possible that many of the so-called vascular symptoms are due to the disturbance of the sympathetic supply to the vessel walls or even to pressure on the main sympathetic supply to the limb which runs in the lower trunk of the plexus. The rib usually can be seen and felt as a hard swelling above the clavicle, while an X-ray film will show it at once. No *treatment* is required unless pressure symptoms are present, but if these are complained of the scalenus anticus muscle is divided or the rib may be completely removed, for the symptoms are usually progressive. This is best done by a straight incision parallel to the posterior border of the sternomastoid ; the scalenus anticus, subclavian artery and brachial plexus are identified and the rib exposed below the omohyoid muscle. The muscle is then divided and if the pressure is thereby relieved no further surgery is required, but occasionally the rib needs removal, its periosteum is then detached from it with a rougine and the rib excised subperiosteally, being traced up to its articulation with the spine and down to its junction with the first rib. By keeping within the periosteum and close to the bone all danger to important structures will be avoided. In some instances a simple section of the scalenus anticus muscle will relieve the condition.

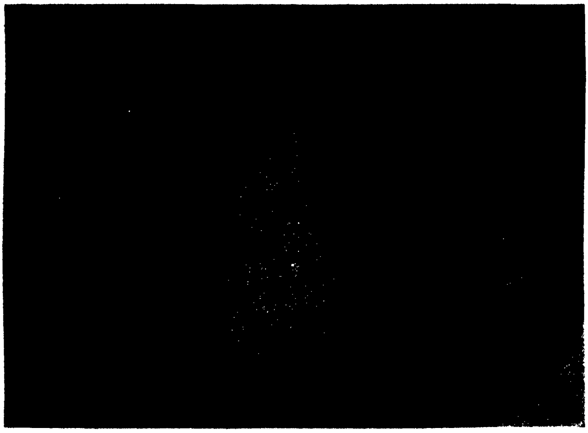


FIG. 138. X-ray film showing a large cervical rib on the right side.

Cases are seen occasionally where there are symptoms similar to those of a cervical rib, but on X-ray examination no signs of such a rib are present. In this case the cause may be either that the normal first rib is unusually near the brachial plexus, which may be post-fixed, and producing pressure upon it, or that there is a strong abnormal band of fibrous tissue corresponding in situation and shape to a cervical rib. The treatment in this case is the division of the scalenus anticus muscle just above its insertion into the rib, or removal of either a portion of the first rib or of the fibrous band, according to circumstances. Rarely a prominent transverse process of the first dorsal vertebra will cause similar symptoms. Syringomyelia has on occasions been mistaken for a cervical rib, but the type of anæsthesia (loss of pain, heat and cold) should distinguish this.

Torticollis. Torticollis or wry neck is a condition in which the head assumes an unusual attitude, it usually being flexed towards one shoulder and also rotated to one or other side. Though in some cases it is due to disease or deformity of the vertebræ, it is more commonly caused by interference with onset of symptoms is partly due to the slight descent of the pectoral girdle which may occur at this time, and also to the fact that as ossification proceeds in the rib more and more disturbance is likely to be produced upon surrounding structures. The condition is often discovered accidentally in the course of a routine examination. The symptoms it produces are of two kinds, and are caused by pressure either on the artery or on the brachial plexus, the shorter ribs being most likely to produce pressure on the plexus, while the longer ones usually implicate the artery. The rib itself often may be felt, while the subclavian vessels are pushed upwards and forwards so that their pulsation is easily visible and palpable; this has at times been mistaken for an aneurysm, the more se as there is often a systolic bruit (see Vol. I., Ch. X.). The pulse on the affected side may be more feeble than on the other side when the arm hangs down, but this is not so noticeable when the arm is elevated, while the hand will be cold, blue and even œdematous ; on occasions, gangrene of the finger tips has been observed ; this usually starts in the index finger and on the right side. In a few severe cases no pulse can be felt from about the middle of the brachial artery downwards. This is almost always a sympathetic effect but may be due to direct pressure on the subclavian artery. In some instances the patient's chief complaint is of a general clumsiness of the arm and hand, while in others the pain is felt mainly in the upper arm and shoulder.

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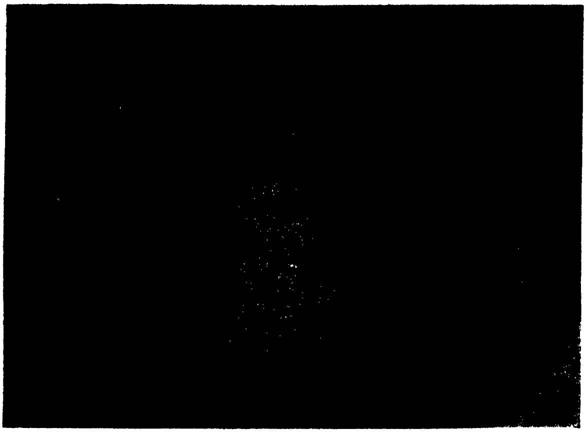

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Acute or Rheumatic Torticollis (Stiff Neck). This is the commonest form and is usually the result of exposure to damp, cold or draughts, though there is probably always an underlying rheumatic tendency in the patient's constitution. Other cases appear to be definitely traumatic and to follow minor injuries of the head and neck. It is largely caused by myositis and fibrositis of the cervical muscles and their sheaths, the sternomastoid and trapezius muscles being chiefly affected and the head assuming the characteristic position. The condition comes on suddenly and causes great pain on movement of the head, while the muscles affected are rigid and acutely tender. In other cases this condition may be really a **Reflex Torticollis**, and then it is due to a spasm of the cervical muscles set up reflexly by some inflammatory lesion in a neighbouring part of the neck, such as an abscess, inflamed cervical glands, carious teeth or spinal caries. The possibility of this last condition must always be remembered and the spine should be investigated carefully. If rheumatic, the condition passes off in the course of a few days, but it may leave a slight wasting of the muscles concerned. It is not infrequently mistaken for such inflammatory conditions as cellulitis or deep abscess of the neck, of which it is in some cases a symptom; these are, however, far more serious conditions (see p. 398). Treatment is general and local. Dry heat and gentle massage should be applied locally, and thermogene wool will be found beneficial. In addition to this the bowels and kidneys must be encouraged to act well, while aspirin and salicylates will soon relieve the pain.

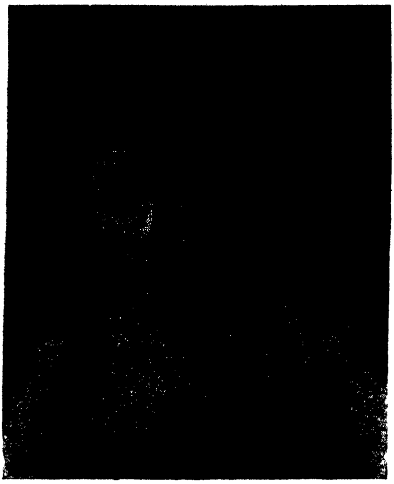


FIG. 139. Congenital torticollis.

Chronic Torticollis. This form is due to organic shortening of the sternomastoid muscle, the same process also occurring in advanced cases in the trapezius, the scalene muscles, the levator anguli scapulæ and the cervical fascia. There is sometimes an exostosis of the clavicle at the point of attachment of the sternomastoid.

It is here that the most characteristic and severe deformity is seen, the head being flexed towards the shoulder on the affected side and the face rotated to the opposite side. The condition persists indefinitely and is quite painless, while if the position is corrected by manipulation it will be found that the whole head looks as if it was displaced towards the sound side.

The sternal head of the affected sternomastoid always stands out as a prominent tight cord, while sometimes the whole muscle is prominent and appears to have been converted almost entirely into a mass of fibrous tissue. If the deformity is severe and has been present a long time, not only are all the other cervical muscles shortened and fibrosed, but the bodies of the cervical vertebræ may have become wedge-shaped and there may be a secondary compensatory scoliosis in the dorsal spine. The base of the skull is sometimes deformed also. In children an atrophy of one side of the face and head often occurs, the affected side being the smaller; the eye on this side will be lower, the cheek flattened, and the mouth dropped, these facial changes being possibly due to an insufficient vascular supply. The skin on the affected side of the neck is often thrown into folds, and though the patient cannot correct the deformity himself, it is possible to lessen it by manipulation. This condition is often described as **congenital torticollis,** but

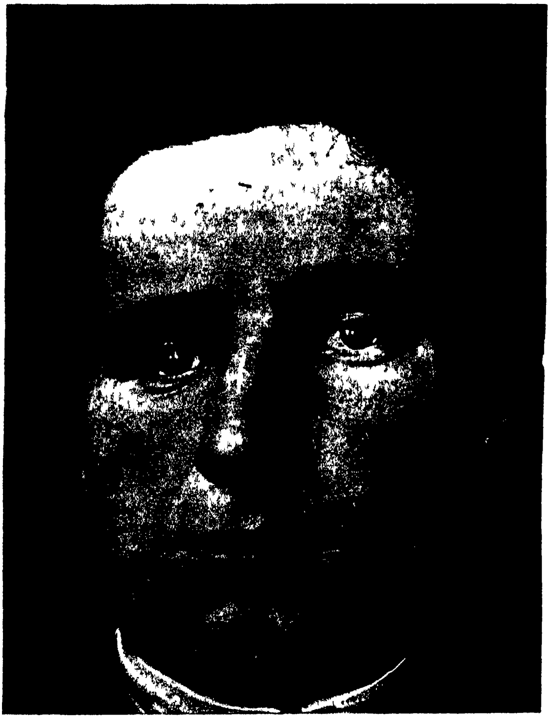


FIG. 140. Facial hemiatrophy as a result of long-standing torticollis.

the patients, when seen, are usually from five to ten years old, so that it is doubtful whether in most cases this is a true description. Probably a few cases are truly congenital, for it is occasionally seen in infants, and at times there is a family history of the condition; in these cases it is probable that the condition is due to an unusual pressure on the neck of the fœtus, which causes the sternomastoid to be deprived of its proper blood supply, with the result that the fibres undergo degeneration and fibrous contraction, this being closely analogous to the condition known as Volkmann's Contracture. More commonly, however, it follows a not unusual condition known as **congenital induration of the sternomastoid.** This is a condition seen in small infants after a difficult birth (especially after breech presentations), and in them it gives rise to a tough, oval, elongated swelling of the muscle, appearing soon after birth, and persisting for some weeks. It is sometimes known as a congenital sternomastoid tumour. The swelling is often a hæmatoma of the sternomastoid due possibly to laceration of its fibres during labour, or more probably to a temporary acute venous obstruction in the muscle during labour. As a result of intravascular clotting in the veins the obstruction becomes permanent. This swelling is at first elastic and soft, and then becomes harder and smaller, eventually disappearing, but months or years afterwards shortening of the muscle occurs and the deformity materialises. Accompanying this condition, other nerve injuries inflicted at birth will be seen sometimes. Occasionally contraction of the muscle will follow the formation of a gumma in its substance, but this is more commonly seen at a later date or in adult life.

The way in which the sternomastoid stands out as a tense band will serve to distinguish the condition of chronic torticollis from cicatricial contraction of the skin following burns or injuries, and from affections of the ligaments and bones of the cervical spine.

Treatment. When the case is seen very early or the deformity is slight, it may be possible to counteract the contraction and produce a cure by manipulation, massage and exercises, but in later cases and cases which are at all advanced operation certainly will be necessary. The old-fashioned operation of subcutaneous tenotomy has now more or less dropped out of use, as in order to correct the deformity it is essential to divide other structures besides the sternomastoid, notably the cervical fascia and portions of the scalene muscles, and this cannot be done subcutaneously with safety. The operation therefore should be done by the open method, a small incision being made parallel to and about half an inch above the clavicle, across the sternomastoid, this muscle, with all tense portions of the cervical fascia and scalene muscles, being then divided. The position of the head is then rectified and fixation will be necessary in an over-corrected position. This may be done by means of plaster of Paris or in a simpler and better fashion by passing one leather strap or bandage round the head and another round the axilla of the sound side. By connecting these two bands by a further bandage or elastic strap, the head can be dragged over and rotated into the required position, which should be the exact reverse of the position in which it was before the operation. With this apparatus the tension can be released for a short period every day, during which time massage and exercises should be performed. After wearing the apparatus for some weeks it is gradually left off during the day, being finally worn only during the night, and then given up altogether. It must be remembered that when considerable osseous deformity in the cervical spine is present no operative treatment will correct the displacement completely, and after the muscles have been cut the head will in this case, though straight, give the appearance of having been moved bodily towards one side.

Spasmodic Torticollis. This is a totally different condition, and is due to clonic and intermittent contractions of certain muscles of the head and neck, whereby the head is being drawn or jerked constantly into the position of a torticollis. In addition to the clonic contractions there is a certain amount of continuous spasm also. The muscles which are usually involved are the sternomastoid and trapezius of one side and the rotators of the opposite side, so that the head is not only continually being jerked into the position of a wry neck, but it is also turned far over towards the opposite side and retracted, the shoulder on the affected side being also jerked up. There also may be constant nodding of the head and contraction of the facial muscles, while as the disease progresses it may spread to other muscle groups. The condition is due to some lesion in the nerve supply of the muscles concerned, probably in the cortex, and it is usually seen in adults of a neurasthenic type with a bad family history of nervous disease, alcoholism, epilepsy, etc. In some instances it is associated with a habit contracted by the patient in the course of his work, or as a result of defective vision. In early cases the movements vanish during sleep, but the condition invariably tends to progress, and in the end sleep may be interrupted and much ill-health and mental depression caused. In other cases inflamed glands or teeth appear to exert an influence upon the condition, but their removal is seldom followed by a cure.

The prognosis is very unfavourable.

Treatment. This should in the first place consist of attention to the general hygiene and health, and all sources of infection and toxæmia, such as constipation, carious teeth, menstrual irregularities, etc., should be set right. Drugs, electricity and massage, and also psychoanalysis, may help. In severe cases a resort to operation will probably be needed, and resection of a portion of the spinal accessory on one side and of the posterior primary divisions of the upper five cervical nerves on the opposite side sometimes will effect a cure. It is essential to resect portions of the nerves, and not merely to cut them, if a permanent result is to be obtained. Division of the muscles which cause the spasms has in other cases given good results, while when all else fails operations have been performed upon the cortical centres concerned.

Hysterical Torticollis. This must be distinguished carefully from the last condition. It occurs as a rule in hysterical young women and, after lasting for some weeks or months, disappears completely under suitable treatment directed at the patient's mentality.

Deformities of the neck resembling torticollis are caused by cicatricial contraction of the skin following burns, ulcers or other infections, while cervical caries (see p. 128) and unilateral dislocation of the spine (see p. 109) will closely resemble it. Scarring and contraction of the sternomastoid muscle is also seen as a result of gummata in its substance, and of its having been infiltrated with tuberculous material from neighbouring glands.

INJURIES OF THE NECK

Contusions of the Neck are produced in many ways and have an important medico-legal bearing. They result from any form of blow or crush, and they may be produced with homicidal or suicidal intent by means of either throttling, strangling, garotting or hanging. Most contusions of the neck are not serious and cause few symptoms other than pain on moving the neck or swallowing; there, however, may be extensive extravasations of blood under the cervical fascia, enough to produce pressure upon the œsophagus or larynx. If the violence has been severe, the larynx or trachea may be crushed or torn and death occur rapidly from suffocation, while later œdema of the glottis may set in. Laceration of the trachea and larynx is usually caused by attempted throttling or a cartwheel passing over the neck, but even if the larynx is only bruised and no laceration has occurred, there is always danger of suffocation for some hours afterwards. Should the air passages or œsophagus be torn, extensive surgical emphysema will result in a few hours, while later severe septic infection of the cellular tissue planes of the neck will arise. Any injury to the neck must be examined carefully with a view to the possibility of medico-legal questions arising later. The marks of fingers or nail prints may be noticeable, and this is evidence that the condition is due to attempted throttling, and is most unlikely to be suicidal. If due to strangling, the mark of the cord can be observed encircling the neck horizontally, but in cases where the condition is the result of hanging the cord mark is usually higher at one side than the other, and always higher at the back than in front. Many bruises of the neck are due to a direct blow, and then the discoloration will be confined to the part of the neck struck.

Fracture of the Hyoid Bone and Laryngeal Cartilages. The hyoid bone is usually fractured by transverse pressure, though a direct blow upon the bone produces this result occasionally. The condition is rarely seen, presumably on account of the mobility of the bone and the fact that it is largely protected by the lower jaw. The site of the fracture is usually at the spot where the great cornu joins the body, and the injury is especially seen in old people in whom marked ossification has occurred. In elderly people the thyroid and cricoid cartilages are frequently calcified, and in this case these cartilages also may be fractured by blows or crushes. The trachea has on occasions been torn or separated from the larynx by similar injuries, and in all such injuries the displacement of the fragments may be very marked, so that there will be a great liability to suffocation.

With all these injuries there is great pain on swallowing, turning the head or moving the tongue, and considerable swelling and discoloration; cough is marked, and there will be a husky voice with pain on speaking. If the air passages are injured there will be considerable difficulty in breathing, either at once or later from œdema of the glottis, while should the mucous membrane be lacerated, hæmoptysis and severe surgical emphysema will soon follow; blood may pass down the trachea and give rise to an intense cough and a grave likelihood of pneumonia. Sometimes crepitus will be elicited, while if the mucous membranes are damaged, after a few days the patient will complain of a nasty-tasting discharge in his mouth.

Treatment. As in these cases there is always a grave risk of respiratory obstruction, either at once or after a few hours, the question of tracheotomy always will have to be considered. This is less likely to be necessary in fracture of the hyoid bone than if the larynx is damaged, and in the former case, if there is much displacement, the fragments may be brought into apposition by moulding them into place with one hand in the mouth and the other in the neck. Tracheotomy can be avoided sometimes by spraying the throat with adrenalin and injections of atropine. After this has been done the neck should be fixed as far as possible by means of a moulded leather collar or by careful strapping for three weeks. Pain and swelling may be eased by means of an ice-bag or other local applications. Should a tracheotomy be necessary, the tube must be left in until all swelling has disappeared.

Cut Throat. A cut throat is a common and dangerous injury, the majority of the cases being suicidal, though homicidal wounds are frequently seen, and many important medico-legal questions will arise in connection with them. It must be remembered that a right-handed suicide is most likely to cut his throat from the left to the right, and such a wound, therefore, will be deeper on the left side and will become shallow towards the right side. Such a suicidal wound is not usually strictly horizontally across the neck, but will be found to slope obliquely upwards at the side at which the weapon leaves the neck. These conditions, of course, are reversed if the patient is left-handed. A suicide usually throws his head back as far as possible before he cuts his throat, and the carotid vessels are thus often protected by the sternomastoid muscles, which are drawn taut; therefore, the vessels frequently will escape injury in cases where the air passages are badly damaged. Instances have been recorded where the vertebral column has actually been damaged with the knife without the carotid vessels being injured. The characteristics of a homicidal wound are different; here the direction and depth will vary according to whether it is inflicted from in front or behind and which hand is employed. (Most homicidal cut throats are inflicted from behind.) The wound inflicted with murderous intent is usually more or less transverse and of equal depth throughout, and in this case the main vessels are frequently divided and the wound is usually much more severe, while any of the structures in the neck, including even the vertebral column and spinal cord, may be damaged. In all such wounds the presence of the platysma under the skin causes the incision to gape widely, while the skin edges are liable to be inverted. In many cases, especially the suicidal ones, the wound is quite superficial, neither the muscles nor the air passages being damaged. In such a case the anterior and external jugular veins may give rise to free hæmorrhage, but this is not likely to be serious and is easily controlled. On the other hand, if the great vessels of the neck are damaged, hæmorrhage may be profuse and death rapidly ensue. Although in the majority of cut throats the wound is made right across the front of the throat, lateral wounds will be seen occasionally, and these are specially liable to damage the main vessels. Instances have been recorded where the wound has been made at the back of the neck and the spinal column damaged. The feature of the case which has the most important bearing both on treatment and prognosis is the question of whether the air passages are involved or not. The air passages may be opened at four different levels :—

(*a*) *Above the hyoid bone.* This is rare. Should this occur the base of the tongue and the floor of the mouth will be involved, the hypoglossal nerve may be cut, and there will be hæmorrhage from the lingual or facial arteries or any of their branches. There is also considerable risk of the epiglottis and the severed base of the tongue falling back over the opening of the larynx and leading to suffocation. If the cavity of the mouth is opened into, the risks of infection in the next few days will be increased greatly, as food and saliva will run out of the wound, while in any case there will be great difficulty in feeding the patient owing to the injury to the tongue.

(*b*) *Through the thyrohyoid membrane.* This is the most common variety. Here the hæmorrhage again comes from the facial, lingual, or superior thyroid vessels and the pharynx may be opened. The main vessels of the neck will escape usually, but the hypoglossal nerve, the arytenoid region of the larynx, the epiglottis, and the depressor muscles of the hyoid may be damaged. There will be considerable pain, therefore, on moving the neck or speaking, but respiration is not likely to be interfered with unless the base of the epiglottis is damaged, or unless portions of detached mucous membrane or blood get into the entrance of the larynx. There is much pain and difficulty on swallowing, and food and saliva will pass out through the wound. In this case also there is a great liability to a severe infection of the whole neck after a few days.

(*c*) *Into the larynx.* These wounds are usually transverse and small, owing to the toughness of the laryngeal cartilages, and there is not likely to be serious hæmorrhage unless the thyroid gland or its arteries are damaged. The vocal cords may be damaged, and this may lead to considerable embarrassment of respiration and marked alteration or loss of the voice, which may be permanent. Coughing will be marked and blood may trickle down into the trachea and cause asphyxia.

(*d*) *Into the trachea.* These wounds are very serious, as the common carotid and inferior thyroid vessels probably will be divided and give rise to rapidly fatal hæmorrhage. In addition, the infrahyoid muscles, the inferior thyroid arteries and veins, the œsophagus, and the recurrent laryngeal nerves may be damaged and asphyxia be caused by displacement of the damaged part of the trachea or by blood trickling down it, whilst air may be sucked into the big veins. If the external wound is small, marked surgical emphysema may occur, but this is not serious. A few cases of total laryngectomy by suicides have been recorded.

After the immediate danger of hæmorrhage has passed important secondary complications may set in. Severe infection of the wound is liable to occur, either from outside or, still more, from the mouth, pharynx or air passages, and this often gives rise to a widespread cellulitis of the neck, with its associated dangers (see p. 398) of œdema of the glottis, secondary hæmorrhage, general septicæmia and mediastinitis.

The other group of complications is due to inflammation of the lungs and air passages, and bronchitis or bronchopneumonia are frequent. This is due partly to the inhalation of septic material, such as pus, food or blood clot, but still more to the fact that the class of patients who attempt suicide usually have a very low vitality, owing to worry, alcohol or privation, the effect of which conditions are increased by the shock of the injury. The difficulty in swallowing, the diminished sensibility of the larynx and trachea, the possible paralysis of the vocal cords and other laryngeal movements all will render food and discharge especially liable to be inhaled. At a later date after the injury an œsophageal, tracheal, or laryngeal fistula may form, while after the wound has healed and the scar tissue has had time to organise, it is not unusual to see a tracheal or laryngeal stenosis with dyspnœa and aphonia. A laryngeal fistula occurs usually through the thyrohyoid membrane, and provided there is no stenosis of the air passages above it, it may be closed by separating the skin and the mucous membrane at the point where they unite and suturing each separately. This, of course, cannot be done if stenosis is present. Œsophageal fistulæ usually close spontaneously. For the treatment of laryngeal or tracheal stenosis see Chapter IX.

Treatment. The urgent requirement is to control hæmorrhage, and this may have to be done by digital compression or by packing the wound. As soon as possible a thorough examination of the wound must be made (preferably under an anæsthetic, which may have to be administered through the opening in the neck), and it may be found that one or more of the carotid vessels will need ligaturing. The incision must be enlarged if necessary and the wound thoroughly cleaned out with antiseptic solutions, the most useful solutions for this purpose being peroxide of hydrogen to cleanse the depths, and ether or iodine to render the wound aseptic; care must of course be taken that these solutions do not run down into the trachea. All hopelessly damaged portions of skin, muscle, and cartilage should be cut away and all bleeding points ligatured. If the air passages are not injured it will be sufficient to suture the muscles and skin and to introduce a small drainage tube for two or three days. If, however, the larynx or trachea are opened the question of inserting a tracheotomy tube for a few days has to be considered. Should the œsophagus be injured, this must be sutured and the patient provided with a gastrostomy wound through which he can be fed for a week or two; or, as an alternative to this, a tube may be passed from the mouth down the œsophagus to the stomach at the time of the operation and left in situ until the œsophagus has healed firmly. If the trachea is opened it is wiser to insert a tracheotomy tube and suture the superficial tissues loosely together round the tube, but the larynx does not tolerate a tube well, so that if the wound is in this situation it is best to suture the opening in the larynx completely and put a small drain down to it. When the larynx is opened, if a breathing tube seems to be required, it is better to suture the laryngeal wound and do a high tracheotomy rather than put the tube in the larynx. If the air passages are opened above the larynx (thyrohyoid space or higher) there is usually no need to introduce any tube to breathe through, and the wound can be sutured in layers with drainage of the superficial tissues. It is important in this situation to notice whether the epiglottis is cut; if so, it should be accurately sutured with silk stitches; the tongue should likewise be sutured if necessary.

The treatment of any dyspnœa that is present is important; its cause should be ascertained and the air passage must be cleared of blood by sucking it out or blowing it out with the intratracheal catheter, and till this is done artificial respiration may be necessary. In all cases it is wise to drain the tissues of the neck to prevent spreading infection and surgical emphysema, while it should be remembered that if in doubt a tracheotomy tube will do no harm. Loss of blood and shock must be dealt with by the usual methods (see Vol. I., Ch. IV.), while it is most important that the patient be fed well from the first, as the general vitality is usually very low. If, therefore, he is unable to take food readily the usual way, there should be no hesitation in feeding him with an œsophageal tube. The head must be kept in a flexed forward position and the patient well propped up with pillows. Suppuration must be expected and counter-incisions may be necessary. Constant supervision is necessary to see that he does not tear off his dressings or attempt his life again, and this supervision is best left to the police authorities.

Wounds of the Thoracic Duct. This duct, which usually opens into the junction of the left internal jugular and subclavian veins by one or more channels, may be opened or cut across by wounds (usually during an operation) at the root of the neck on the left side. It should be borne in mind specially when removing glands on this side of the neck. Jets of milky fluid will be forced out of it at each expiration, if it is cut. If it is injured during an operation this may not be noticed, and then the chyle will be found running out into the dressings after a few hours. If there is only one duct, and that is cut so that all the chyle escapes, the patient will waste rapidly, and suffer from intense thirst and weakness; in fact he may die, but it is more common to find that other channels exist, and in this case the flow of chyle will cease soon and the patient will not be so affected. At other times the wound will heal so that the chyle cannot escape, and then a painless fluctuating swelling will slowly form under the scar; this will disappear in time. At times the chyle has found its way into the pleural cavity and caused a condition of chylothorax.

Though an attempt to suture the duct or to anastomose it afresh into a vein may be made, it is not likely to succeed, and should any treatment be required the best procedure is simply to ligature the end of the duct and suture the wound tightly. A collateral circulation will be set up soon by means of the smaller duct on the right side, and by radicals communicating with the hemiazygos and azygos veins.

Subcutaneous rupture of the duct has occurred in crushes of the thorax or in association with a fracture of the spine, while it has been opened by the ulceration of a malignant growth. If the duct has been blocked by the pressure of glands or growths, the receptaculum chyli may distend and rupture into the peritoneum. Any form of subcutaneous rupture is likely, therefore, to lead to chylous ascites (p. 556) or chylothorax.

Attempts have been made to benefit cases of general septic peritonitis by ligature of the thoracic duct in the neck. It is possible that this procedure may hinder the infecting organisms from passing into the general circulation.

INFECTIONS OF THE NECK

Cellulitis of the Neck. Cellulitis is common in the neck, and in many ways is especially dangerous in this situation. It may occur in any of the cellular tissue planes, but the most serious form is that which occurs under the deep cervical fascia. Here it is usually secondary to some septic lesion in the mouth or throat, such as carious teeth, tonsillitis, diphtheria, or a scarlatinal throat, the tissue planes of the neck being involved by means of direct extension from an infected lymphatic gland. The infecting organisms are usually streptococci, and when pus is formed it tends to spread widely throughout the connective tissue spaces, so that in this way it will come into intimate contact with all the important structures in the neck, while the fact that it is held in under tension by the dense cervical fascia will cause it to track downwards into the mediastinum. In this case it gives rise to empyema, mediastinitis or pericarditis, while in other instances it may spread along the subclavian vessels into the axilla. Œdema of the glottis and venous thrombosis leading to pyæmia are often seen, and in other cases intracranial lesions in the form of sinus thrombosis, meningitis, or cerebral abscess will occur. Extensive sloughing of the muscular and cellular tissues of the neck may result.

The neck rapidly becomes swollen, dusky red and brawny, while severe pain of a deep character is complained of, the head being bent towards the diseased side and the pain increased on moving it. The swelling spreads rapidly, and is very tender and œdematous, while though pus may form quite early it is frequently impossible to obtain fluctuation, and actual pointing seldom is seen. Marked constitutional disturbance will be present with rigors, high fever, and a rapid pulse, and the patient soon may become toxic and exhausted. Other symptoms will arise in the neck according to which important structures are pressed upon. Pressure upon the air passages or œdema of the glottis will give rise to intense dyspnœa, and frequently an early tracheotomy will be necessary; dysphagia may be set up by involvement of the pharynx or œsophagus, and irritation of important nerves will cause referred pain or twitching. Erosion of big vessels leading to hæmorrhage is not infrequent.

Occasionally in children a more localised form of the disease will be seen in the submaxillary region, giving rise to a hard, rounded, boggy and not very painful localised swelling without great constitutional disturbance. These cases may take a long time before they form pus, and may in some instances slowly resolve without suppuration.

Treatment. The primary cause in the throat must be treated and sulphanilamides given, while the patient's general vitality may be assisted by the administration of quinine, perchloride of iron and alcohol. Locally antiphlogistine or hot fomentations should be applied at first, but if, after twenty-four hours, the condition is still spreading, and the swelling is brawny and œdematous, incisions will have to be made through the deep fascia to look for pus. It cannot be insisted upon too strongly that it is unwise to delay incisions until fluctuation and obvious signs of suppuration are present, for by this time the patient may be desperately ill or signs of respiratory obstruction develop urgently from œdema of glottis. The sites of the incisions are often indicated by points of maximum tenderness or brawniness, while the pus often will be found very deep down in the midst of a mass of matted tissues, and this may render the operation by no means a simple one. It is safest to make these incisions by Hilton's method of opening the skin with the knife and exploring the deeper tissues with a blunt instrument. In severe cases the use of antistreptococcal serum is advisable, while complications will have to be treated as they arise. More than one incision, often made on subsequent days, very likely will be necessary, while drainage must be thorough, but it is better in the neighbourhood of big vessels to avoid tubes and use strips of rubber tissue. It is not unusual to find no actual pus, but merely seropurulent fluid. If secondary hæmorrhage occurs it may be necessary to ligate one of the main vessels, while in many cases the presence of urgent dyspnœa will demand a tracheotomy before anything else is done. Such cases are usually dangerous cases to anæsthetise, and a very small amount of anæsthetic should be given.

Ludwig's Angina. A special form of the above condition occurs in the neighbourhood of the submaxillary salivary gland and under the chin. The infection in this case probably starts from some focus in the mouth, though it may be due to a spread of infection from a lymphatic gland, or, in other cases, from the middle ear. This gives rise to a swelling in the submaxillary region, which rapidly spreads forwards under the chin and into the floor of the mouth, pushing the tongue up and even protruding it from the mouth. Œdema of the glottis frequently occurs, and often will need a tracheotomy. After being present a few days the condition may localise down to form a sublingual abscess. The treatment is the same as that of cellulitis elsewhere in the neck.

Actinomycosis occurs more commonly in the neck than elsewhere in the body, and in most cases spreads thither from the lower jaw (see p. 178). It gives rise to a dense, wooden, hard, slowly spreading swelling, which sooner or later breaks down to form multiple sinuses in the discharge from which the characteristic sulphur granules and filaments of the ray fungus may be found. The condition is painless and exceedingly chronic. For a further description and treatment see Ch. VI., Vol. I.

Boils and Carbuncles are frequently seen on the back of the neck where the thick coarse skin is rubbed by the collar (see Vol. I., Ch. IX.).

Cervical Lymphatic Glands. The diseases of these glands are fully described in Vol. I., Ch. XI.

CYSTS OF THE NECK

A variety of cysts are met with in the neck, some of which are due to abnormalities in development, and are therefore only seen in the neck, while others, which may be called acquired cysts of the neck, are similar to those seen in many other parts of the body. The first group, those which are due to abnormalities of development, may be regarded as congenital cysts, and most of these arise in connection with various tubes, clefts, or ducts, which should normally disappear; they, therefore, may be classed broadly in the two groups of tubulo-dermoids (branchial and thyroglossal cysts) and sequestration-dermoids.

Branchial Cysts. These are due to the distension with fluid of an unobliterated portion of one of the branchial clefts and they are, therefore, closely allied to branchial fistulæ (see p. 386). They are more common in females and usually are noticed at about eighteen years of age and arise in connection with the third cleft, when they lie near and appear in front of the anterior border of the sternomastoid between it and the thyroid cartilage or the hyoid bone, to which structure they may be attached. When large they will extend beneath the sternomastoid muscle. A less common type has its origin in the second cleft, in which case it appears just below the mastoid process, and the cyst may then be attached either to this portion of bone or to the styloid process, and this latter type of cyst may project inwards under the floor of the mouth. Most of these cysts are lined with a squamous epithelium, but occasionally one will be encountered which is deeper in the neck and nearer to the pharynx, and it then may be lined with a columnar or even ciliated epithelium. Rarely this type are connected with the pharynx and these can be inflated by the patient if the nose is held during a forced expiration (*aerocele*). Those near the skin contain a pultaceous semi-fluid yellowish matter, usually rich in cholestrin, while the deeper ones are found to contain a clear mucoid fluid. If they burst spontaneously they will give rise to a branchial fistula (see p. 386). Though essentially congenital, they are usually noticed for the first time in adolescence between the ages of twelve and twenty-five, and give rise to spherical fluctuating swellings which are painless, grow slowly and do not appear to be attached to the skin or deeper structures. On palpation it is found that the cysts contain no solid tissue in their walls and are lax, and the patient sometimes may state that they have been caused by an injury. If this is so, it may be that the injury causes the secretion into the pre-existing cleft to commence. Those near the lower half of the sternomastoid are usually oval, with their long axis pointing upwards, and if allowed to remain they will grow slowly to a great size. Occasionally such cysts communicate with the pharynx when they can be blown up by the patient in forced expiration with the mouth shut and the nose closed with the fingers. Their treatment consists in complete removal when convenient, and this is usually easily done, as they are not adherent to surrounding structures, unless they have been inflamed. It is wiser not to allow them to go on growing too long, as there is some evidence that a peculiar form of carcinoma may arise in branchial cysts or fistulæ (see p. 403).

Thyroglossal Cysts. The thyroglossal duct of His is a diverticulum growing out of the pharynx in early intrauterine life and passing down the neck behind the hyoid bone and in front of the larynx to give rise to the isthmus of the thyroid gland and to the pyramidal lobe of that gland, the upper opening of this duct being marked by the foramen cæcum of the tongue. This duct normally should disappear completely, but if any part of it remains unobliterated it may become distended with secretion and give rise to a thyroglossal cyst. Such a cyst arising in the upper part of the duct will be situated in or under the tongue, where it constitutes a tubulo-dermoid.

If, however, the cyst arises from the lower part of the duct it gives rise to a small, spherical, translucent fluctuating swelling in the middle line of the neck or slightly to the left of it, not attached to the skin, and just above or below the hyoid bone to which it is adherent. Such a cyst does not as a rule appear until after the age of five, and is quite painless and very slowly increases in size. These are specially liable to attacks of inflammation and suppuration, and should one suppurate or burst spontaneously it will give rise to a thyroglossal fistula (see p. 387). At any point down the course of this duct small accessory thyrŏid growths may occur ; these are usually seen at the back of the tongue. They are quite innocent in character, and unless causing trouble are best left alone.

Treatment. A cyst of this kind had better be excised before it bursts. It may be a tedious and difficult operation, but complete removal is essential, as otherwise a sinus will result (see p. 387). Even after the most carefully performed operation recurrence is not infrequent. Division of the hyoid bone may render success more likely.

Dermoid Cysts. Ordinary skin dermoids (sequestration-dermoids) are occasionally seen in the midline of the neck. They are small cystic swellings not attached to the skin or to the deeper structures, painless, and appearing in children. Bigger ones are sometimes seen beneath the tongue. They are easily removed.

Cystic Hygroma. This condition, otherwise known as a cystic lymphangioma or hydrocele of the neck, is usually seen in children under the age of ten. It also occurs in the axilla, subscapular region and groin. It is usually congenital, though it is often not noticed for some years and consists of a large multilocular cyst containing lymph and due to dilatation of lymphatic spaces, which are cut off from the general lymphatic circulation and surrounded by œdematous fibrous tissue. It sends tails and prolongations in between various muscles, and may extend deeply into the tissues, even into the mediastinum, but it is not in the strict sense adherent either to the skin or to the deeper structures. Clinically it appears as a large, lobulated, soft, painless, flaccid or flabby cystic swelling, usually at the root of the neck, which causes no symptoms unless it is big enough to produce pressure upon important structures. The tissues above it may be in a condition of lymphatic œdema and the skin over it be bluish or næviform, while the swelling will be translucent on transillumination. The cyst not infrequently contains in its walls a certain amount of solid lymphoid tissue, and is particularly liable to recurrent attacks of acute inflammation accompanied by heat, pain, swelling, redness and fever, after each of which attacks this solid tissue may increase in amount, while the cystic portion may diminish in size, and even ultimately be cured. When in this condition it will resemble an abscess closely, but it does not need incising.

Treatment. If possible these swellings should be removed by dissection, though this may well prove a most difficult operation. The results of radium and X-ray therapy are on the whole disappointing.

Sebaceous Cysts occur in the neck as elsewhere.

Serous Cysts. These are unilocular lymph-containing cysts, which are seen in the lower part of the neck. They are really minor degrees of the condition known as cystic hygroma (see above).

Blood Cysts. These are occasionally found in the neck and are due usually either to a cavernous angioma or a diverticulum of a large vein, in which case they are compressible, have an impulse on coughing and present a venous thrill. In some instances they are caused by a hæmorrhage occurring into a pre-existing branchial cyst or cystic adenoma of the thyroid. If causing symptoms they should be excised, due precautions being taken to control the hæmorrhage.

Enlarged Subhyoid Bursa. The small bursa which is found between the back of the hyoid bone and the thyrohyoid membrane may become enlarged and distended with fluid, and this will give rise to a small, tense, oval, painless fluid swelling, lying across the midline of the neck immediately below the hyoid bone and upon the thyrohyoid membrane. It will not be attached to the skin, but will be loosely incorporated with the lower part of the hyoid bone. This swelling will move up and down on deglutition, and if troublesome should be excised. Such a bursa will resemble closely a thyroglossal cyst. It, however, may be distinguished by the facts that it occurs at a later age and has its long axis across the neck instead of vertically, while on microscopic section the bursa is lined with endothelium and the thyroglossal cyst with epithelium.

Other cysts, which are occasionally met with in the neck, may arise in connection with the salivary glands (see p. 214), or the thyroid gland (see p. 416), or they may be hydatid cysts or malignant cysts due to degeneration of malignant growths either in lymphatic glands or in branchial clefts.

The *differential diagnosis of* these various cysts is important. It must be remembered that thyroglossal cysts, cysts connected with the thyroid gland, and subhyoid bursæ move up and down on deglutition, whereas the other cysts do not, while in some cases cold abscesses will resemble closely these conditions. Such a cold abscess usually arises either from tuberculous perichondritis of one of the laryngeal cartilages, in which case it is attached to the larynx and moves on deglutition, or from the breaking down of a lymphatic gland, in which case swallowing does not cause it to move up and down ; but a cold abscess usually has a shorter history, attachment to and reddening of the skin over it, and in its wall can be felt portions of solid tissue, which are remnants of the gland from which it arose. The true congenital cysts are usually roughly spherical in outline, while cold abscesses may be flattened or irregular in shape.

An **Aerocele** is a very rare air-containing cyst, formed by projection of the sacculus of the larynx, or of the tracheal mucous membrane between two rings. It is reducible on pressure, resonant, and has an impulse on coughing. Players of wind instruments and Mussulman criers occasionally suffer from it (see also p. 400).

A **Pneumatocele** is a hernia of the lung apex into the root of the neck (see p. 436).

SOLID TUMOURS OF THE NECK

The great majority of solid tumours of the neck are either due to diseases of the lymphatic glands (Vol. I., Ch. XI.) or of the thyroid gland (see p. 409).

If such a tumour appears to consist of several different rounded masses fused together it is almost certainly a collection of enlarged glands.

Simple Growths. The ordinary *lipomata* are common in the neck and shoulder, and in these situations they occasionally alter their position and move downwards in the course of years, sliding down under the skin from the action of gravity, while at the back of the neck and under the skin a special form of this tumour, known as *diffuse lipomatosis*, is seen. This occurs in persons of a chronic alcoholic type; the condition slowly increases in size and ultimately may spread right round the neck; the ordinary double chin may be regarded as a mild form of this disease. The fat in these diffused lipomata is not encapsulated, and their removal is therefore not easy, nor is it often required, as the condition is symptomless and can be controlled by reduction of the diet and alcohol consumption. Localised lipomata should be removed in the ordinary way (see Vol. I., Ch. VIII.).

Rare innocent tumours in the neck are *fibromata*, arising in the periosteum of the vertebræ, and *osteomata* or *chondromata* of the bones of the spine, while occasionally mixed tumours (*myxochondro-endotheliomata*) are seen similar to those which arise in the salivary glands, but which appear to arise independently of these glands in other parts of the neck, possibly in the remains of branchial clefts. The majority of these mixed tumours will be found in the parotid or submaxillary glands (see p. 217).

Malignant Growths. Many malignant growths will be seen in the neck, the diagnosis in most cases being obvious on account of their size, rate of growth, hardness, intimate attachment to the surrounding structures, deep tissues and skin, and also from the pain which they cause. In many cases the skin over these growths will be red and injected, or the mass may even be fungating, while in other instances portions of the tumour will be fluctuating owing to the growth breaking down. The majority of these tumours are masses of **Carcinomatous Glands** (see Vol. I., Ch. XI.), secondary to primary growths (squamous epitheliomata), in the mouth, tongue, lips, pharynx, œsophagus, larynx, nose, or ear, and before any other diagnosis is entertained search must be made for these primary growths; secondary lymphosarcomatous glands, the primary being in the tonsil, are sometimes met with. It must not be forgotten that occasionally a carcinoma of the stomach will give rise to a mass of secondary glands at the root of the neck on the left side (glands of Virchow), the malignant cells having possibly reached that situation by passing up the thoracic duct. Sooner or later most of these masses of malignant glands will ulcerate through the skin, and as they not infrequently involve large vessels, secondary hæmorrhage is common.

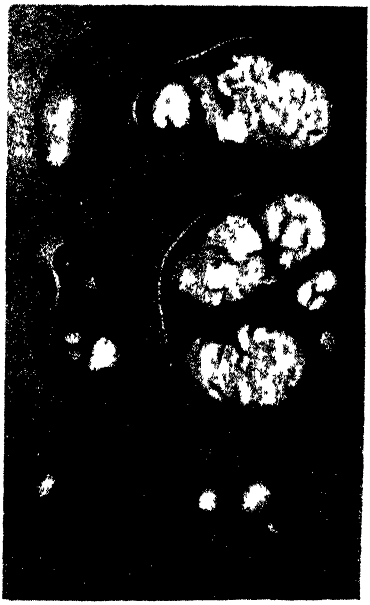


FIG. 141. Caseous tuberculous glands.

Branchial Carcinoma. This is a rare form of primary carcinoma of the neck, and is a squamous epithelioma which is thought to arise in connection with one of the branchial clefts, usually the second. Before such a diagnosis can be made we must be assured that no primary growth, to which the tumour in the neck is secondary, is present. Many authorities have denied the existence of such a primary branchial carcinoma, explaining the presence of the epitheliomatous swelling in the neck as being secondary to either a primary focus which cannot be detected, or to a small primary epithelioma in the area of lymphatic drainage, which has undergone spontaneous disappearance and cure, leaving the secondary glands behind. There is, however, little doubt that such a primary branchial carcinoma does exist, though it is very uncommon ; it is more often seen in men than women at middle age, and gives rise to a hard, fixed tumour of rapid growth, deeply placed under the sternomastoid near the hyoid bone and soon infiltrating the submaxillary region. The surface of the swelling is usually much smoother than the knobbly, bossy mass produced by the fusion of malignant lymphatic glands. Some patients will state that a small swelling has been present at this spot for many years (possibly a branchial cyst), and that recently it has increased in size rapidly. It causes considerable pain and may attain an enormous size, but even when very large it does not seem to affect the general health. Lymphatic glands in the immediate neighbourhood will become secondarily involved, but there seems to be no tendency to form metastases elsewhere in the body.

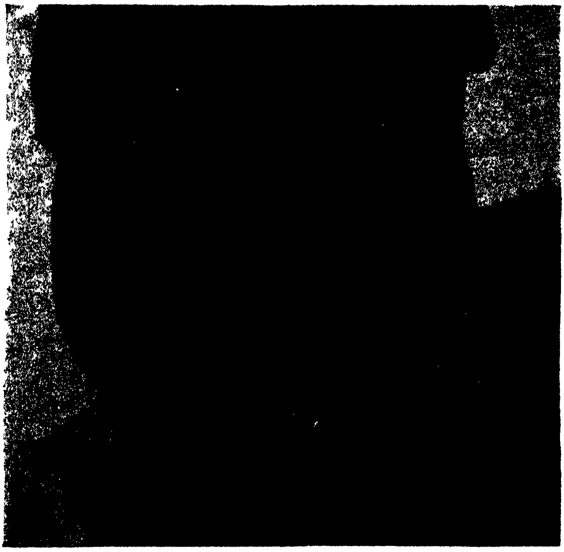


FIG. 142. Lymphosarcoma of the neck in a man of thirty-seven.

Epithelioma of the Neck. Epithelioma of the skin of the neck is rarely seen, but occurs occasionally in paraffin and coal tar workers as the result of irritation, while at other times it may supervene upon the scars of an old lupus or a burn. For its characteristics and treatment see Vol. I., Ch. IX.

Lymphosarcoma. This is not infrequent in the neck and arises either in the lymphatic glands or else in the tonsil. It may be distinguished sometimes from other malignant tumours by its very rapid growth and spread, its comparative softness, its occurrence in younger patients, and the fact that it rapidly involves many different groups of glands in the neck. For a full description see Vol. I., Ch. XI.

Other forms of sarcoma and fibrosarcoma of a more slowly growing type occasionally arise in the fascial and fibrous structures of the neck, while endotheliomata and peritheliomata (see Vol. I., Ch. VIII.) also occur here.

Treatment. In many cases the treatment of a malignant tumour of the neck will depend very largely upon the condition of the primary growth which has given rise to it. The presence of a mass of secondary glands in association with a primary carcinoma in the mouth or throat always renders the prognosis very much worse, and if the secondary glands are at all big and fixed, the condition had better be regarded as inoperable, though X-ray or radium therapy often leads to temporary improvement and gives corresponding relief to the patient. In the case of primary malignant tumours of the neck it will be found also that a great many of them are inoperable when first seen, though they may disappear or become removable after radium or X-ray treatment. If the tumour is large, if the skin over it is ulcerated, or if it is immovably fixed to the deeper structures, it will not be possible usually to remove it, while many other cases which appear to be fairly freely movable nevertheless will be found to be incapable of complete removal when the attempt is made. Attachment to or infiltration of surrounding muscles need not necessarily prevent removal, nor need involvement of the internal jugular vein, of the vagus, or of the cervical sympathetic cord, as these structures can be sectioned without any special risk. Involvement of the internal or common carotid arteries, on the other hand, may well be regarded as rendering the growth inoperable, as ligature of these vessels is liable to be followed by cerebral softening or hemiplegia.

Branchial carcinomata are often less adherent and more easily removed than other malignant growths, while lymphosarcoma, on the contrary, is particularly rapid in its infiltration, and seldom is operable. Radium has been extensively used in these malignant growths in the neck, and while it does not appear to benefit the hard carcinomata to any great extent, many cases of lymphosarcoma are much reduced in size and even disappear (probably only temporarily). Possibly some cases of lymphosarcoma are benefited by lead treatment.

The treatment of epithelioma of the skin of the neck consists in radium therapy or in its free removal together with a block dissection of all the glands on that side of the neck (see p. 208). Inasmuch as lymph-gland cells are more sensitive to X-rays than the implanted malignant cells, X-ray and radium therapy, though they cause temporary disappearance of the metastatic masses, leave islets of undestroyed malignant cells among the scar tissue, and these tend to recur rapidly and infiltrate extensively the fibrous tissue devoid of lymphatic cells.

Tumours of the Carotid Body. The carotid body normally lies at the junction of the internal and external carotid arteries, and is probably derived from the column of cells which ultimately develops into the sympathetic ganglia. It gives rise to two varieties of tumours :—

(1) Simple, highly vascular, slow-growing growths, which are microscopically peritheliomata (see Vol. I., Ch. VIII.).

(2) Very malignant growths, which are known as **Potato tumours** from their peculiar greyish translucent appearance on section. Microscopically these latter growths consist of a cellular fibrous stroma, which is not very vascular and contains irregular endothelial-lined alveoli, with occasional single

nucleated giant cells in them. Such a tumour is often intimately attached to all three carotid arteries, while the internal and external vessels wrap round it and indent it, so as to give it a waist, and its rate of growth varies considerably; sooner or later it will implicate the sternomastoid, the jugular vein, the vagus, or the sympathetic. It gives rise to a large, lobulated, ovoid swelling, stony hard, and under the upper third of the sternomastoid, which is painless and does not involve the skin. The swelling will move comparatively freely across the neck, but does not move freely up and down the neck, on account of its attachment to the vessels. Transmitted pulsation often will be present, but no true expansile impulse. A differential diagnosis is often very difficult, for the condition closely resembles any other malignant growth in the neck. Metastases do not occur for a long time.

Treatment. The only possible treatment is complete excision; this will be found usually to be a most difficult operation, even when the growth appears to be movable, as the main vessels and nerves are very likely to be involved. The surgeon, therefore, must be prepared to resect portions of any of the carotid vessels, the jugular vein, or the vagus, and there will be a considerable risk of cerebral complications following this.

THE THYMUS GLAND

This gland originates as an outgrowth from the third and fourth branchial clefts and lies chiefly within the thorax, but may project upwards into the neck for a certain distance. It has no known function, has a well-marked capsule and begins to diminish in size after the second year, and by the time puberty is reached it should have entirely disappeared. It not infrequently happens, however, that this involution of the thymus gland does not take place, while it may even increase in size, and in this case it will be liable to produce pressure upon any of the important structures entering the upper aperture of the thorax. This hyperplasia of the gland is often accompanied by a hyperplasia of the spleen and all the lymphatic tissue in the body, and gives rise to a condition known as **Status Lymphaticus,** which in children appears to give rise to sudden death on small provocation, especially under an anæsthetic. Such a child has often a peculiar appearance, being flabby and pasty-faced, with dark rings round his eyes.

Sometimes definite pressure is produced by the gland upon the trachea, and this will give rise to paroxysmal and progressive dyspnœa and stridor, with retraction of the chest, but no movement of the larynx. Attacks usually occur in a child at irregular intervals, and it will be noticed that it is only expiration that is troublesome, as during expiration the thymus gland is pushed up into the suprasternal notch, where it may be felt as a soft swelling, while during inspiration it is sucked down again into the mediastinum and the trachea is thus relieved from pressure. Thus the child's cry may be very muffled, and the attacks will be accompanied by distension of the cervical veins. The condition may be distinguished from laryngismus stridulus, for in this latter disease there is inspiratory dyspnœa, the larynx is drawn down, and the child can cry lustily with a peculiar note. When urgent this dyspnœa may need a tracheotomy, an especially long tracheotomy tube being used which will pass right down the trachea behind the sternum; in order to prevent recurrence an incision should be made down to the suprasternal notch and the gland brought up into the neck by dragging on its capsule. This capsule is then incised and the gland can be completely removed if desired.

The thymus is also found to be enlarged in exophthalmic goitre, Hodgkin's disease, and in leukæmia. Cysts occasionally occur in it, due to the degeneration of Hassal's corpuscles, and they may suppurate and cause an abscess which points above the suprasternal notch. Dermoid cysts and sarcomata have been seen in the gland; they give rise to dyspnœa, engorgement of the neck, fulness above the sternum and dulness to percussion over the bone. An X-ray film will demonstrate them, and occasionally they can be removed.

DISEASES OF THE THYROID GLAND

Surgical Anatomy. This gland consists of three main portions, two lateral lobes, one at each side of the trachea, and an isthmus which joins these two lobes and runs across in front of the second, third and fourth tracheal rings. The so-called pyramidal lobe is occasionally present and runs up from the left side of the isthmus, while in certain enlarged conditions of the gland (especially Graves' disease) various outlying and retrolaryngeal lobules will be found. The gland lies underneath the sternohyoid and sternothyroid muscles and is closely connected to the larynx and trachea by the pretracheal layer of the cervical fascia, which surrounds it, the isthmus especially being densely adherent to the front of the trachea over a small area. It is contained in a thin capsule of its own, as well as the cervical fascia, and is supplied with blood by the superior and inferior thyroid arteries and frequently by the thyroidea ima vessel which runs up to the isthmus. A free anastomosis occurs between the vessels supplying the isthmus and those lying within the trachea. Both inside and outside its capsule are numerous large veins, which run into the internal jugular and left innominate vessels, while behind it and between the larynx and œsophagus are the recurrent laryngeal nerves, which break up into a number of filaments just before they pass into the larynx and are there closely associated with the inferior thyroid artery. This nerve appears to be particularly sensitive, and a minor injury, such as touching it, or mild degrees of squeezing or stretching, which would have no effect on most nerves in the body, are quite sufficient to put it and especially its abductor fibres out of action for a prolonged period. The lymphatics of the gland run into the deep cervical and anterior mediastinal glands. The thyroid gland varies greatly in size from time to time, and such conditions as pregnancy, menstruation or puberty frequently give rise to an increase in size. As it enlarges it pushes the carotid vessels outwards, while the jugular veins come to lie rather in front of its lateral borders; when much enlarged its upper poles almost will reach the base of the skull.

Accessory thyroids are not uncommon and are usually closely attached to one of the lobes. They, however, may occur independently anywhere on the line of the thyroglossal duct and are not infrequently seen at the base of the tongue, near the foramen cæcum, or between the tongue and the hyoid bone.

Acute Thyroiditis. The thyroid gland is highly vascular and is very rarely involved by ordinary inflammatory processes, tuberculous or syphilitic disease in it being practically unknown. Acute inflammation is occasionally seen in a gland which is either normal or already enlarged, and is due to infection by ordinary pyogenic organisms which reach it either through an infected wound in the neck or else from some local infection close by, such as an abscess, cellulitis, or impacted œsophageal foreign body; while at times it may result from an infection brought by the blood stream during an acute infective disease, such as rheumatism, scarlet fever, typhoid, influenza, malaria or septicæmia The old-fashioned practice of injecting irritants into thyroid cysts often gave rise to this disease. Suppuration nearly always occurs. Either one lobe or the whole gland may be involved and the gland becomes acutely painful and tender, enlarged and hot; the skin will be red and the veins over it dilated. Dyspnœa and dysphagia, headache and vertigo may be caused, while the temperature will be very high and the pulse rapid, the general reaction usually being most severe. When pus forms in addition, there will be rigors, œdema and fluctuation, while if the infection spreads outside the capsule grave cellulitis of the neck will follow (see p. 395.)

Treatment. In the early stages the application of leeches or an ice-bag are beneficial, and should be accompanied by general treatment in the form of diet, purging and rest in bed. If this does not relieve the condition in forty-eight hours, or in any case as soon as pus forms, it should be let out with free incisions and hot fomentations applied.

Chronic Fibrous Thyroiditis (Reidel's Disease) is a condition in which the gland becomes converted into densely hard fibrous tissue, which may surround and compress the trachea, causing much stridor. The gland is tough, hard, and larger than usual, the condition usually being seen in women over forty. Signs of myxœdema are usually present. From its age incidence and hardness this condition is naturally frequently mistaken for carcinoma. X-rays afford considerable relief, while if stridor is marked the isthmus should be exposed and divided to release the trachea. Hemithyroidectomy is often necessary.

GOITRE

The expression " goitre " may be applied to any non-inflammatory enlargement of the thyroid gland, and we have to consider several different types of goitre. The thyroid being an important ductless gland, its diseases have to be considered with reference to their general effect on the metabolism of the body as well as their local phenomena in the neck, and it is found that total absence or failure of function in the gland produces the condition of **myxœdema** in adults, with an accumulation of mucin in the body, and an œdematous condition of the face and extremities. The pulse is slow, the skin is rough and dry, the hair falls out, the voice is lowered, croaking and harsh, and the patient is dull, melancholic and constipated with a subnormal temperature, while she looks pale, fat and bloated. A similar condition occurring in children leads to one form of dwarfism known as **cretinism.** Here the thyroid gland is small and fibrous and the child is dwarfed and idiotic, the development both of mind and body being greatly delayed ; the hands are stunted and spade-like, the body fat, there being marked hard, fatty pads in the supraclavicular regions, the epiphyseal unions are delayed, and the bones often unduly brittle. In both these conditions the administration of thyroid extract will produce great improvement.

The secretion of the thyroid gland is poured into the veins and distributed over the body, and an excessive formation of normal or possibly abnormal thyroid secretion is the cause of Graves' disease, while there is no doubt that the thyroid has an important influence on nearly all the other ductless glands in the body, in particular the pituitary, and upon the growth of the bones.

When the thyroid is abnormally active, a condition of hyperplasia occurs in the gland, and it becomes unusually vascular and forms an increased amount of colloid, the alveoli becoming distended into large spaces lined by the flattened epithelial cells. This is the change seen in parenchymatous goitres (see p. 410), while in that form of goitre known as exophthalmic goitre a much more advanced change will occur (see p. 416). The probability is that two substances are secreted by the gland, one of which is passed directly into the circulating blood and one is stored in the vesicles as colloid and passed into the blood stream as required. The quantity of colloid in the gland therefore represents a store or balance, but this gives no indication of its rate of transference into the blood stream.

The ultimate result of these changes in the gland may be either a return to a more or less normal state, or else an intense fibrosis which causes atrophy of the gland tissue with loss of function and myxœdematous symptoms. An approximate measure of the activity of the thyroid gland and its influence upon bodily metabolism may be obtained by estimating what is known as the basal metabolic reaction ; this is obtained by chemical examination of the expired air ; if the figure is unduly high, it denotes hyperactivity, and if low, hypoactivity, of the gland.

Thyroid Enlargements. An enlargement of the thyroid may be (i) *diffuse* and involve the whole gland or (ii) be *localised* to one part of it. In the case of a diffuse enlargement the swelling roughly resembles the horse-shoe shape of the normal gland, the two lobes and isthmus being distinguishable, although one lobe, usually the right, will be enlarged more than the other ; the localised enlargements may consist of one or more isolated round swellings in the substance of the gland, or occasionally take the form of an enlargement of one lobe only. If the isthmus is unduly enlarged the normal shape of the gland will largely disappear. All thyroid swellings are intimately attached to the larynx and trachea, and therefore will move up and down on deglutition, there being only two exceptions to this very important diagnostic feature :—

1. Malignant goitres, which have become adherent to surrounding structures and so cannot move (see p. 422).
2. Retrosternal goitres, which have become firmly impacted in the upper opening of the thorax (see p. 412).

If a goitre is too heavy for the elevators of the larynx to lift it, during deglutition it will be tilted forwards instead of rising up in the neck.

In all forms of goitre there may be a certain degree of anæmia, while pressure on surrounding important structures or displacement of them often will be seen. The structures liable to be compressed or displaced are the trachea and larynx, the main vessels, the recurrent laryngeal nerves and the œsophagus. Compression is naturally more likely to occur with diffuse enlargements, and displacement with localised enlargements. Any moderately large goitre will displace and compress the trachea, flattening it from side to side (scabbard trachea), and pushing it away from the midline, while in time atrophy of the tracheal cartilages will be produced by the pressure, and this may cause severe stridor and dyspnœa. In the case, however, of a retrosternal goitre the trachea will be flattened from front to back. Involvement of the recurrent laryngeal nerve, which leads to hoarseness, aphonia and occasional attacks of dyspnœa and cough, is very rarely seen except in malignant cases. The œsophagus is rarely involved, except by malignant or very large goitres, and this will cause dysphagia, while it is most unusual to see pressure upon the main veins and arteries of the neck (which may produce cerebral symptoms), except in association with malignant disease. When the trachea is severely compressed or its cartilages are softened, alteration in position of the patient may produce sudden attacks of respiratory distress, while

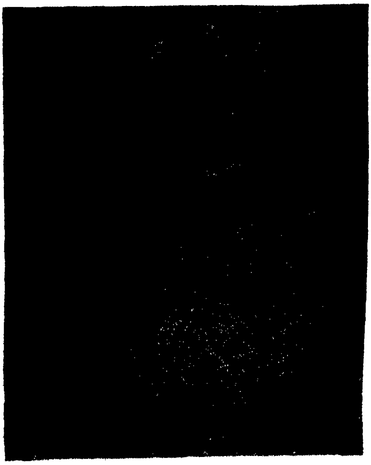


FIG. 143. Large parenchymatous goitre in a lady of fifty-five.

in all these cases there will be catarrh and engorgement of the tracheal mucous membrane, which leads to excessive secretion of mucus, much cough, and not infrequently to bronchitis and emphysema.

Very vascular goitres often will pulsate, while in the case of those which have large engorged veins running over them, a hand laid gently on the neck will perceive a marked venous thrill, and a loud bruit will be heard. This is especially common in Graves' disease.

Enlargements of the thyroid gland may be associated either with hypothyroidism or hyperthyroidism.

It must be remembered that the fact that a swelling in the neck moves up and down on deglutition is not conclusive evidence that it originates in the thyroid, as affections of the laryngeal cartilages and inflamed lymphatic glands which have become secondarily adherent to the larynx also will have this motion.

Parenchymatous Goitre (Bronchocele, Derbyshire Neck). The so-called simple non-toxic parenchymatous goitre occurs all over the world, but is particularly common in certain districts, some of which are hilly and others are not. In this country it is seen especially in Derbyshire, Gloucestershire, the Eastern counties, Oxfordshire, Devonshire and parts of Scotland; Switzerland, the Great Lakes of America, Serbia, the north of India and Egypt are districts where it is also common. It is more common in women than in men, and usually commences before the age of thirty-five. There appears to be little doubt that its cause is conveyed in the drinking water in the district in which the patient lives, though whether it is an undetected infection or a chemical constituent possibly associated with a limestone formation has not been proved. Goitrous patients apparently are able to infect a water supply and thus give the disease to other people, and in a district where the condition is common, children are liable to be cretins, though there is no evidence that the condition is transmitted through a family, and if the goitrous parents move to a non-goitrous district they will produce healthy children. If drinking water is boiled it appears to lose its power of producing the disease, while certain localities are known in which there are two distinct sources of water supply and where patients who drink from one supply become goitrous, whereas those who imbibe the other supply do not. The disease has often disappeared from a neighbourhood where it was rife, after the water supply has been changed. McCarrison has suggested that the drinking water possibly contains some infecting organism which in the intestinal canal of man produces a peculiar toxæmia, which in its turn causes the disease. He has found that water capable of producing the disease does not do so if filtered, but that material ex-

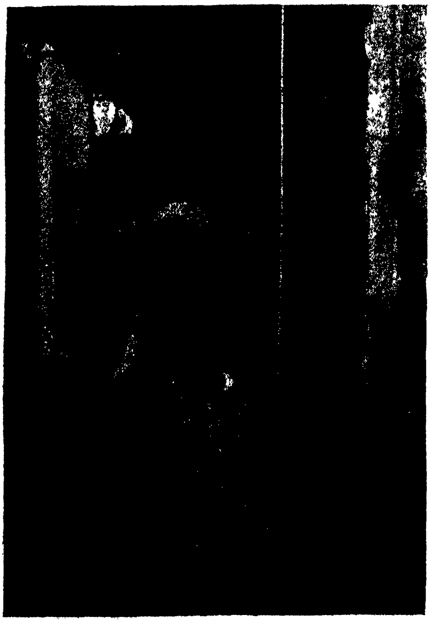


Fig. 144. Large parenchymatous goitre.

tracted from the water by the filter will produce the disease, while the disease can be prevented or improved by means of intestinal antiseptics. No organisms have ever been grown from the goitre itself, nor has any definite causative organism been cultured from the fæces, but toxins derived from the fæces of goitrous patients will cause the disease in animals. There may be other contributory causes, such as lack of fresh air and the influence of other ductless glands, while it is not improbable in some cases that the thyroid gland enlarges because, for some reason or other, it finds it more difficult to extract iodine from the blood than it should do in order to form the thyroid secretion, and in this case its enlargement may be looked upon as a compensatory hypertrophy in response to having to perform an increased amount of work.

Morbid Anatomy. Both the secreting and connective tissue elements of the gland are enlarged in a parenchymatous goitre and the change is diffusely spread throughout the whole organ, though in many cases one or other part of it will be chiefly involved. Occasionally outlying accessory lobes constitute the bulk of the swelling, which will then be of a most unusual and irregular shape. It is not uncommon to find large cystic dilated spaces filled with yellow colloid material, and when these changes are pronounced and lead to large cysts, the condition is known as a **Cystic goitre,** and it often then will attain a particularly big size. In other cases the fibrous connective tissues of the gland are chiefly affected and the whole gland becomes fibrosed (**Fibrous goitre**). If this process becomes unusually marked, the secreting elements may disappear altogether as the result of their strangulation by the fibrous tissues and the gland will then cease to function and myxœdema will result. The vascularity of such goitres varies enormously, many of them being tough and fibrous while others are soft and pulsating, and may vary in size with changes in the blood pressure. Calcification, leading to the formation of stony masses (**Thyroid stone**), is not uncommon in old-standing goitres.

Clinical Features. Parenchymatous goitres do not produce any marked toxic symptoms (see p. 416), and the patient's only complaint is, as a rule, either of the disfigurement caused by the swelling or of pressure effects on the surrounding structures. Any mild toxæmia which may be present only consists of slight nervousness, tremor, and a little elevation of pulse rate, there being no changes in the eye or the heart. The swelling moves freely up and down on deglutition and can be pushed to and fro across the neck. It is not adherent to surrounding structures, and is usually soft and smooth, with its edges gradually slipping away into the surrounding tissues and without any definite rounded border. If multiple large cysts are present in it, it will be knobbly, bossy and irregular. The effects of pressure are usually confined to the trachea and the patient will complain first of shortness of breath, and later of both inspiratory and expiratory stridor. Before such stridor is noticed it may be brought into being sometimes by gently squeezing the goitre, while

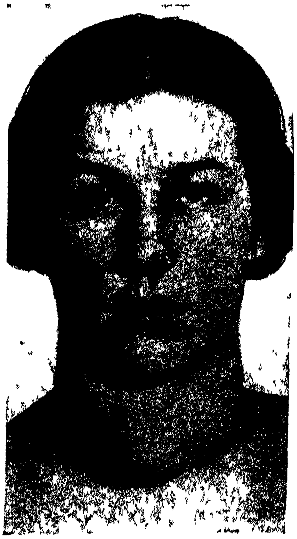


FIG. 145. Puberty goitre in a girl of fifteen.

the patient will often find that it is worse at night when lying down and that he sometimes wakes up with a sudden start and feeling of distress. There is no aphonia as a rule, as it is very unusual for a simple goitre to involve the recurrent laryngeal nerve, nor will dysphagia be likely unless the swelling is very big. Giddiness and fulness in the head, with syncopal attacks, are sometimes complained of.

There is usually no change in the basal metabolic reaction in a parenchymatous goitre, any slight alteration being, as a rule, a reduction in the reaction figure.

Sudden and rapid increase in the size of the gland with a marked aggravation of symptoms, sufficient occasionally to produce fatal dyspnœa, sometimes occurs, and these effects are due to a hæmorrhage either into the substance of the gland or into one of the cysts which it contains.

Occasionally after persisting for many years a parenchymatous goitre will develop the symptoms of malignant disease or of Graves' disease.

There are certain special forms of parenchymatous goitre; the fibrous and cystic type we have already mentioned. In addition there are :—

Puberty goitre, which is seen in patients between the ages of ten and fifteen, usually girls. It comes on rapidly and gives rise to a large, soft, uniform swelling, encircling the whole of the neck, causing great disfigurement, but usually with no other symptoms, except possibly a small amount of stridor. This hardly can be regarded as a pathological condition, as microscopically it consists of perfectly normal thyroid tissue, and it must be regarded as an excessive hypertrophy in some way connected with the physiological changes of puberty. Similar thyroid enlargements may occur around the menopause or during pregnancy; their treatment should be medical.

Retrosternal goitre, which is occasionally seen. These are usually parenchymatous, but may be adenomatous (see p. 414), and in this case either the whole or part of the swelling runs down behind the sternum into the thorax. In some instances there is a very large rounded mass entirely within the thorax, and nothing abnormal can be felt in the neck. In other cases, on swallowing or violent coughing, the tumour will be forced up into the neck and become palpable; this latter variety is known as a "plunging goitre." Such a goitre causes excessive pressure on the trachea and marked dyspnœa and stridor, which often come on in paroxysmal attacks, and are associated with much bronchitis and emphysema. There will be engorgement of the veins of the neck with lateral displacement of the trachea, dulness over the upper half of the sternum and the signs of a tumour in the upper part of the mediastinum. The tumour can be demonstrated easily in an X-ray film, as a deep rounded shadow, lying in the midline behind the upper half of the sternum. It can be seen on the screen to move up and down on swallowing, and is the only form of intrathoracic tumour which does this.

Treatment. In most cases of parenchymatous goitre the treatment should be medical in the first instance. It is wise for the patient to leave the neighbourhood if he lives in a goitrous district, and, if possible, he should drink only distilled water, his general health being put as far as possible in the best condition. It will be found often that if he is supplied with iodine in the form of tincture of iodine, Lugol's iodine or potassium iodide by the mouth, or with dried thyroid extract, the goitre will diminish largely in size, while in other cases inunction with iodide of mercury ointment and exposure to sunlight have proved beneficial. Potassium iodide may be given in doses of 5 grains three times a day or Lugol's iodine to start with and gradually increased, while the initial dose of thyroid extract should be grs. i. b.d.; this can be increased, but careful watch must be kept on the pulse rate in case signs of hyperthyroidism should develop. In some cases administration of extract of the anterior lobe of the pituitary combined with iodine gives good results, and this is particularly so in puberty goitre.

Operation will be indicated in cases where the goitre is very large, where it increases in size in spite of medical treatment, where it appears to be giving rise to toxæmia and signs of hyperthyroidism, and where it is definitely producing pressure upon the air passages or other structures, and it is important that this should be performed before the tumour has become very big. The least suspicion of the goitre becoming malignant is a strong reason for excising it. We must remember in performing a thyroidectomy that care must be taken to leave sufficient of the gland behind to prevent the patient from becoming myxœdematous, and though in the case of a highly toxic gland quite a small portion of gland tissue may suffice, this is not true in the case of the ordinary parenchymatous swelling. Thus in this latter condition the operation will consist usually in a hemithyroidectomy, one lobe of the gland being removed, preferably the bigger one. It is, however, important to see that sufficient gland tissue is removed to prevent any chance of further pressure on the trachea, and it will be found that after the operation the remaining portion of the gland will move over and partially take the place of that part removed. Much discussion has arisen with regard to the best form of anæsthesia to use for this operation. Though the operation can be done quite easily under infiltration with a local anæsthetic, there seems to be no need for this in the case of non-toxic goitres. Local infiltration of the cervical plexus with novocaine is another method that may be employed, but in most instances the intratracheal administration of ether will be found the most satisfactory method. This will remove any danger of dyspnœa or suffocation should the trachea be unduly pressed upon during the operation, and though ordinary open ether is often quite safe, it will give the surgeon a sense of security if there is a catheter in the trachea.

In the case of a retrosternal goitre the treatment always consists in its removal. This may be a difficult operation, as the goitre has to be brought up through the superior aperture of the thorax, and in this case we regard an intratracheal anæsthetic as essential. In some cases if the retrosternal goitre is a large one, it will be necessary to split the sternum and separate the two halves. At times disarticulating the inner end of the clavicle will make the procedure easier.

For the description of the operation of thyroidectomy see p. 425.

X-rays should never be used for parenchymatous goitre, as they are very likely to cause myxœdema.

The attacks of sudden and urgent dyspnœa to which patients with goitre are occasionally liable may require instant operative treatment for their relief. In this case an incision through the skin and muscles, which divides the isthmus, may relieve the pressure, but if this fails a tracheotomy with the introduction of a long tube down the trachea will be required.

Acute hyperthyroidism following operation (see p. 421) does not often occur in these simple goitres, while tetany, though theoretically it might follow if there is interference with the parathyroids, is practically unknown after thyroid operations properly performed.

A puberty goitre very rarely requires surgical treatment and nearly always will disappear with potassium iodide or thyroid extract. Thyroidectomy should never be considered here unless medical treatment has definitely failed or stridor is present.

Adenoma of the Thyroid. In this form of goitre enlargement of the gland is due to the formation within it of one or more encapsuled adenomata of varying size, analogous to those which occur in the prostate or breast. The rest of the gland tissue is at times normal, but in some cases also presents a considerable amount of parenchymatous hyperplasia, and some authorities regard the adenomata as degenerated hyperplastic areas; this is borne out by the facts that encapsulation is often imperfect and degenerative changes are frequently met with. These adenomata are always solid to commence with, and may remain so throughout their course, but they often show a marked tendency to undergo cystic degeneration, and in this case part of the adenoma becomes a round cyst containing clear yellowish fluid. Not infrequently there is old dark blood in the cyst, while small nodular intracystic outgrowths may be found growing from its walls. Thus an adenoma of the thyroid may give rise to another form of cystic goitre (see p. 416), and it should be remembered that no swellings in the thyroid are cystic in the first place, but that any cysts which are found are formed as the result of degeneration in a pre-existing goitre. Two varieties of adenoma occur in the gland :—

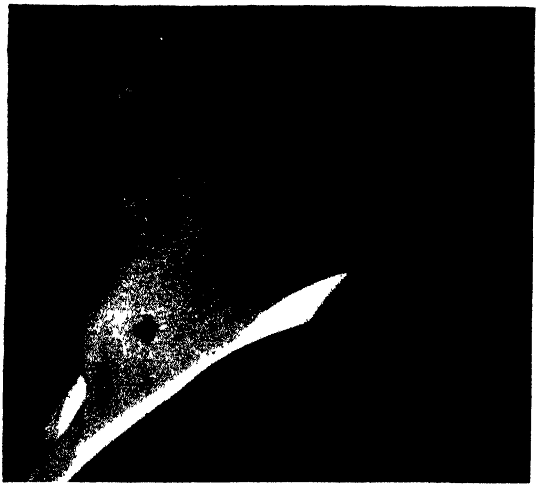


FIG. 146. Adenoma of the isthmus of the thyroid.

1. The fœtal (true) adenoma. These are solid, and consist of small alveoli containing no colloid and closely packed together, similar in structure to embryonic thyroid tissue. They probably arise in islets of this embryonic thyroid tissue between the alveoli, and they may be stirred into growth by the same causes which produce parenchymatous goitre. This form usually occurs in young patients, and is solitary, small and vascular, shows no tendency to undergo cystic change, is completely encapsuled, and sometimes appears to recur slowly after removal, though it is in no sense malignant.
2. The common type of adenoma, which resembles ordinary adult thyroid tissue, contains colloid and exhibits a marked tendency to degeneration. This type is frequently multiple and seldom completely encapsuled from the surrounding gland.

Adenomata may occur anywhere in the substance of the gland and are frequently seen in the isthmus. The gland becomes enlarged, but not uniformly so ; it is uneven, and the separate rounded swellings caused by the adenomata can be distinguished and sometimes may be felt to move about within the gland substance, but it is often very difficult in these swellings to say whether fluctuation is present or not. Such an adenoma will continue to grow in size slowly but steadily, and in time it will become very large and may produce marked displacement of, or pressure upon, the trachea.

Adenomata have been recorded at times in the remains of a lingual thyroid, and have then given rise to rounded painless swellings at the back of the tongue, sometimes causing difficulty in deglutition and respiration.

It will be found that adenomata of the thyroid are not infrequently accompanied by a mild degree of toxic symptoms (hyperthyroidism). This will be shown by nervousness, tremor, a slightly rapid pulse, and occasional attacks of palpitation. In more advanced cases these toxic symptoms become more marked, eye and heart changes occur and the condition becomes one of secondary Graves' disease (see p. 419). This type of secondary Graves' disease, due to an adenoma, is especially liable to develop auricular fibrillation.

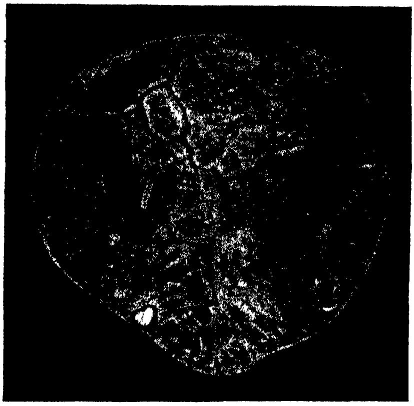


FIG. 147. Section of an adenoma of the thyroid undergoing early cystic change.

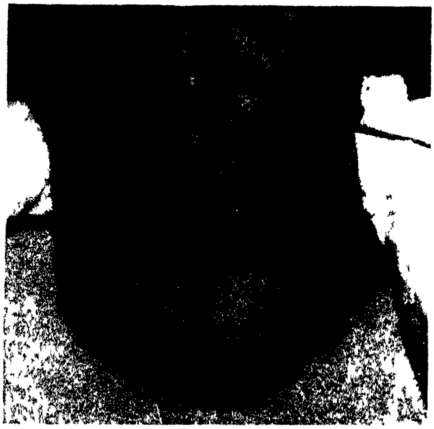


FIG. 148. Parenchymatous goitre with an adenoma in its isthmus, which had been present for twenty years.

It is uncertain whether this toxæmia is produced by the adenoma or by the gland tissue round it. Although by definition a new growth has no function it must be remembered that tumours of the other ductless glands do appear to have an active function, as is seen in the pituitary, prostate, suprarenal, etc.

When a diffuse parenchymatous enlargement is present as well as one or more adenomata, this will often conceal or partly conceal the adenoma. If in a case of this kind medical treatment is given, the parenchymatous swelling may decrease in size and the adenoma become more noticeable ; the patient then may say that the medicine is making the swelling larger.

At times sudden severe hæmorrhages may occur into the substance of adenomata or adenomatous cysts without any very obvious cause. Severe pain and rapid swelling of the tumour will be caused at times sufficient to give rise to intense stridor, and need urgent operation for its relief. If this is necessary it is best to remove the adenoma then and there if possible.

There is little doubt that adenomata of the thyroid may become malignant and that quite a large number of cases of carcinoma of the thyroid arise in pre-existing adenomata.

Treatment. The treatment of adenoma of the thyroid is essentially surgical, as no drug or other medical treatment will retard the increase of what is essentially an innocent new growth, and as it will continue to increase slowly but indefinitely, it is better to remove it when it is small. This is all the more important if stridor or hyperthyroidism is present. In some cases, where the whole of one lobe is occupied by one or more adenomata, a formal hemithyroidectomy is the wisest course, while in others, where there is a single tumour, it sometimes may be shelled out of the surrounding gland by blunt dissection; but as this is liable to lead to a considerable amount of hæmorrhage it usually will be found wiser, if a hemithyroidectomy does not seem suitable, to perform the operation known as resection-enucleation, in which the adenoma with a small portion of thyroid tissue on each side of it is deliberately resected out of the gland, any vessels tied, and the cavity in the gland sutured together (see p. 425).

In the past cystic tumours have been tapped and irritants, such as iodine, injected into them, but this is not to be recommended, for it may lead to acute thyroiditis, and later to recurrence.

Cystic Goitre. As mentioned above (see pp. 411, 414), this condition essentially arises as a degeneration in a pre-existing adenomatous or parenchymatous goitre. The cysts may be single or multiple and are lined by an epithelium, which may be either cuboidal or squamous. The contents usually are a thick grumous fluid, and as hæmorrhage is by no means uncommon into the cyst this fluid will often be bloodstained. Sudden hæmorrhages may occur into them and cause rapid increase and urgent dyspnœa, while such a cyst often later undergoes secondary changes, and portions of its walls may become cartilaginous, osseous, calcareous, or even malignant. The treatment always consists in removal.

Exophthalmic Goitre (Toxic Goitre, Graves' Disease, Basedow's Disease). This is a form of enlargement of the thyroid which differs from any of the preceding in that it is always accompanied by marked toxic symptoms and general constitutional effects—almost certainly due to the occurrence of changes in the thyroid gland, which cause the body to be flooded by an excessive amount of thyroid secretion, either normal or more probably abnormal. Enlargement of the thyroid may be small or moderate, and it is not often very big, but on palpation it is tough, hard and friable, while the thin borders of the normal gland, which appear to pass off insensibly into the surrounding tissues, are changed and become thick and rounded, so that the gland stands out as a firm, rounded collar across the front of the neck.

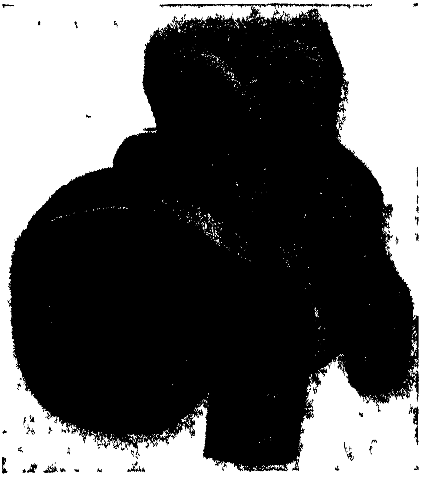
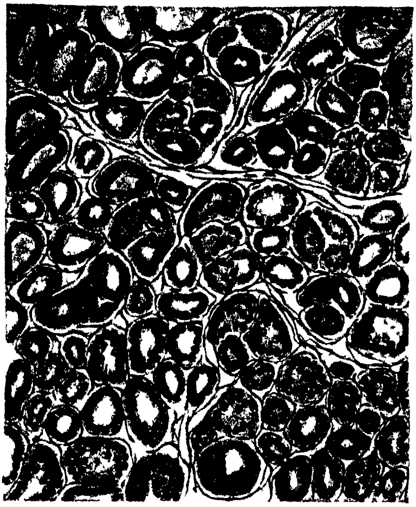
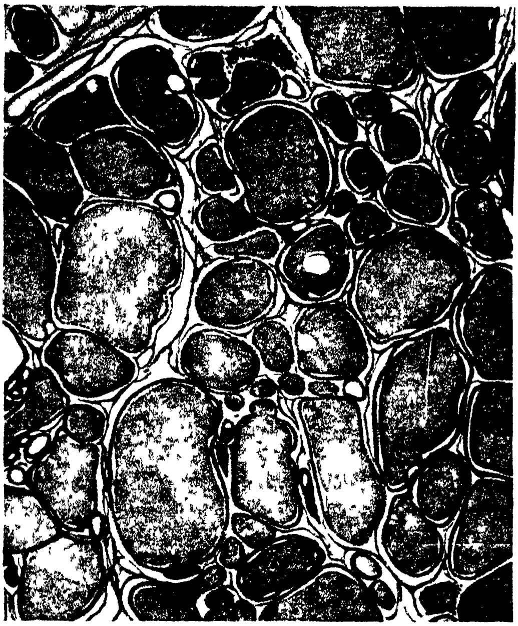


FIG. 149. Large cyst in the right lobe of the thyroid gland.

Such a gland has large dilated veins running over it, and is itself extremely



A.



B.

FIG. 150. (A) A section of the thyroid in parenchymatous goitre showing slight fibrosis. (B) Section of a colloid goitre showing the marked increase in the colloid present and the flattening of the alveolar walls.

vascular, while microscopically it is more solid than usual, the alveoli are small, more closely packed together than in the normal gland, and contain no colloid. Their epithelium has undergone a proliferation, and the alveolar wall is infolded and appears to project into and block the lumen of the alveolus in a way rather resembling a papilliferous outgrowth, while the nature of the epithelium usually will be found to have changed from cuboidal to columnar. The interalveolar connective and fibrous tissue is much more vascular than usual and is infiltrated with round inflammatory cells, the gland thus becoming condensed into a solid mass of vascular tissue with small and few alveoli and no colloid. The whole picture is, therefore, one of intense secretory activity, the colloid being poured into the blood stream as fast as it is formed and not stored up at all, and it does not in the least resemble the parenchymatous goitre, with its soft honeycomb appearance. In severe cases the thymus gland and spleen will be found to be markedly enlarged, while blood changes often will be present, consisting of marked anæmia with a leukopenia and a lymphocytosis. Some authorities regard the disease as possibly being due to overaction of the thyroid, to compensate for lack of some other endocrine secretion, with the result that the patient suffers from a more or less acute thyroid toxæmia. This would account for some cases of recurrence after apparently successful treatment.

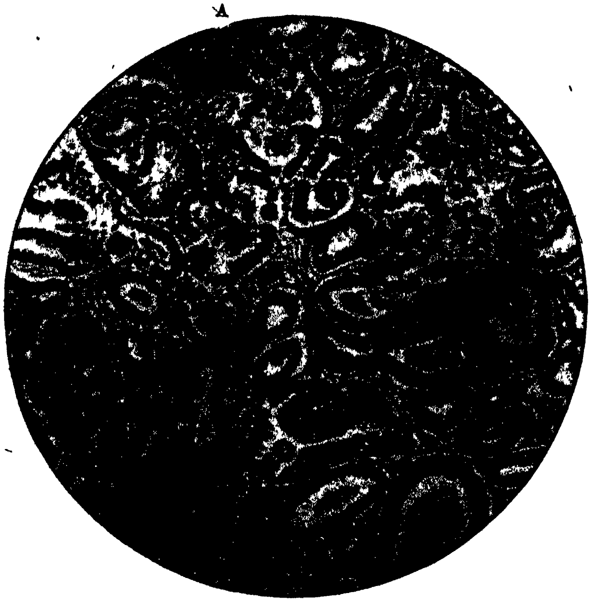


FIG. 151. Exophthalmic goitre × 100. Note the absence of colloid, hypertrophy of the epithelium, and lymphorrhages (A).

The disease is much more common in women than men, and the patients are usually of fair complexion and between the ages of twenty-five and fifty. It is rare in children, but has been seen from the age of four up, therefore no age can be said to be exempt. The patients are often of a neurotic disposition, overwork, worry and prolonged mental strain being apparently the predisposing causes in some instances. At other times cases will be seen which have come on rapidly within a few days after a severe fright or shock. School teachers seem to be particularly liable to the disease. Any of the symptoms may be the first to appear, but in most instances palpitation, shortness of breath and tiredness are the first complaints. The thyroid swells and gives rise to a uniform, firm, rounded swelling, the right lobe being almost invariably larger then the left; it occasionally pulsates and, owing to the enlarged veins over it, a venous thrill often will be felt and a loud continuous hum (bruit de diable) be heard. *The eyes become prominent and the eyeballs stick forward. Occasionally this is so marked that the eyes cannot be closed, and the con-*

junctivæ and lids become œdematous, while corneal ulceration may set in; in other cases a white ring of sclerotic always can be seen between the cornea and the lid. In milder cases this white ring will appear only as the patient transfers his gaze from something above his head to something below it, the upper lid seeming to lag behind as the eyeball moves (Von Graefe's sign). In very early cases the first eye sign to be noticed is a peculiar shininess of the cornea, which gives rise to a glinting look in the eye, and it sometimes will be found that the palpebral fissure is enlarged, the pupils dilated, and the patient stares without winking frequently. The cause of the exophthalmos is not known for certain; it may be caused by stimulation of the sympathetic fibres to the eye, but is sometimes undoubtedly due to excessive fat deposit in the orbit, while another theory to account for it is that it is caused by spasmodic contraction of the muscle of Müller at the back of the orbit. Both eyes usually are equally prominent, but cases are occasionally seen in which only one eye sticks out; this is not necessarily on the same side as the largest lobe of the thyroid. It is an interesting biological fact that the thyroid plays a very important part in the metamorphosis of such animals as the tadpole and certain amphibians, and that giving them doses of thyroid or removing their thyroid glands produces great alterations in the rate and method of metamorphosis. During metamorphosis and under the influence of thyroid feeding, exophthalmos becomes very marked in most of them, as in the case of the tadpole, which becomes very exophthalmic while changing into a frog.

A fine tremor of the hands and other parts is present, and the patient is exceedingly nervy and jumpy, often unable to keep still, and starting at any sudden sound. The skin is moist and warm and sleeplessness much complained of, the patient often waking with starts and bad dreams. The pulse is always rapid and soft, and on the least exertion may become extremely so, its rate varying from 90 to 180 to the minute or more, and this rapid and turbulent action of the heart, with the continuous palpitation it causes, is one of the most distressing symptoms. The basal metabolic reaction is always considerably raised, and in advanced cases diarrhœa and vomiting, loss of weight, acetonuria, mental delirium, and pallor, followed by a patchy, muddy discoloration of the skin, will set in. The heart is always enlarged (from dilatation) from the commencement, and in advanced cases this may become extreme, the apex beat being far out in the axilla. In the end myocarditis, with fibrillation and cardiac failure, often sets in, and this is the most common cause of death. Such patients are often slightly febrile; they are much upset by hot weather and do not feel cold. They have a peculiarly low resistance to infections of any kind, such as sepsis or pneumonia. Spontaneous cure very rarely occurs, and the majority of untreated cases will die either within a few months or years from cardiac failure, diabetes or intercurrent infections, or else remain permanent invalids with the most precarious hold on life. The prognosis is therefore poor and the disease must be regarded as a most serious one. There are several common complications which may almost be regarded as symptoms in severe cases. (1) Fibrillation. (2) Glycosuria. (3) Mental derangement. (4) Gross emaciation. (5) Localised myxœdema seen in the form of puffy swellings, especially on the anterolateral part of the legs above the ankles. (6) Pruritus. (7) Mucinous degeneration of the skin, and in children (8) Sexual precocity.

Excess of thyroid secretion causes loss of calcium from the tissues and thus severe *osteoporosis may be seen in Graves' disease.*

Primary and Secondary Graves' Disease. Primary Graves' disease is the name given to that variety in which the glandular enlargement and the toxic manifestations appear together so that the gland may be regarded as "toxin-producing" from the first, whereas in secondary Graves' disease there has been an enlargement of the thyroid, either parenchymatous or adenomatous, and usually the latter, for many years without toxæmia; the toxic symptoms gradually appearing after some time. The secondary form is not usually very severe, all the very bad cases being primary ones. It is quite possible that the primary disease is due to an abnormal thyroid secretion and the secondary form to an excess of normal secretion. Secondary Graves' disease is frequently accompanied by auricular fibrillation. Even if this latter complication is present, most cases of secondary Graves' disease do remarkably well after operation.

Treatment. Medical treatment is usually first adopted and should be tried for some months. This consists in absolute rest in bed, no excitements, and the administration of such drugs as iodine, Lugol's solution, strontium bromide, quinine hydrobromide, and arsenic, while the ductless gland secretions may prove beneficial. X-rays, very occasionally, and the external application of radium more frequently, will prove beneficial, though should an operation later prove necessary these two methods of treatment will render it more difficult. In many cases none of these methods will prove of avail, and after they have been tried for a few months, if the patient is not improving, recourse should be had to surgery before her general condition becomes too bad. This is usually followed by excellent results, though the operation is not devoid of risk in some very severe cases. Rapidity of pulse rate and cardiac dilation are not in themselves contra-indications to operation; but evidence that marked heart failure is occurring, as shown by œdema, etc., or the presence of marked mental instability, renders operation inadvisable. Fibrillation is not necessarily a bar to operation: in fact such cases usually do remarkably well, especially those due to secondary Graves' disease, where the fibrillation sometimes disappears within three days of the operation.

The operation of choice in most cases is a thyroidectomy, performed on the usual lines (see p. 423), but in the case of Graves' disease a hemithyroidectomy will never be sufficient, and it is necessary to remove as much as possible, usually one lobe, the isthmus, and a portion (from a half to seven-eighths) of the opposite lobe. It is important that those portions removed should be removed completely, and no little outlying projections of gland tissue left behind, as these may later give rise to a recurrence of symptoms if not removed. In this disease outlying lobules and retrolaryngeal projections of gland tissue are specially common, and must be looked for. The exophthalmic gland is particularly vascular, and usually very adherent, while the fact that it is hard and friable renders the operation very much more difficult than in the case of a simple goitre.

Some surgeons have advocated in bad cases that no attempt should be made to remove a portion of the gland, but that two or three of the main thyroid arteries should be ligatured. This operation is, however, rarely practised nowadays in this country, for its results are unsatisfactory; for if the patient is so bad that it is the only operation feasible, it is not effective enough to be in the least likely to do any good. It may occasionally be useful in very elderly cases with delirium at night or other mental changes. The older procedure of section of the cervical sympathetic for this disease need be mentioned only to be condemned.

The question of which anæsthetic should be used in these operations on exophthalmic goitres is a vexed one, and the risk and mortality of the operation probably largely depends upon the anæsthetic employed. Chloroform in these cases is most dangerous, and we do not regard intratracheal ether as suitable, on account of the manipulation of the neck which it entails, while in this condition there is very seldom any stridor. In the mild cases gas and oxygen or a minimal amount of open ether assisted by an injection of morphia is usually quite safe, while avertin or paraldehyde in the rectum, followed by gas and oxygen, are very satisfactory. There is little doubt that in more severe cases no inhalation anæsthetic should be employed, and, in these bad cases, the operation is best done under local anæsthesia, either by direct infiltration of the neck or by blocking the cervical plexus. This is greatly assisted by the administration of avertin, or better rectal paraldehyde first. During the operation the gland must be handled as gently as possible, and at the end drainage for forty-eight hours should be employed, both these measures being adopted in order that as little thyroid secretion as possible should be forced out of the gland into the blood stream. Most cases will be benefited by a fortnight's course of Lugol's solution by the mouth (♏ x b. d.), and for a few days before operation this should be increased to ♏ xv t.d.s. The beneficial effect of this seems to wear off within a fortnight, but it has become almost a routine preliminary. Iodine treatment produces a rapid change in the microscopical appearance of the gland which corresponds with the clinical improvement. Involution occurs and the microscopic section comes more to resemble the normal gland in appearance. In other words, iodine treatment " spoils the section."

Severe cases of the disease are liable to an unusual complication immediately after the operation, though this is very seldom seen now. It is known as **acute hyperthyroidism.** It comes on within two or three hours of the operation and causes a rapidly increasing pulse rate, the pulse rising to over 200 and becoming flickering and irregular. The temperature rises to 103° or 104°, the patient shows air hunger and becomes restless, delirious, or even maniacal, flinging herself about and being quite uncontrollable. The face is flushed and red and sweating profuse. The breath and urine are full of acetone, and in most cases where this condition sets in death from exhaustion occurs within forty-eight hours. The only treatment likely to prove of avail should this set in is to take out the stitches and wash the wound out with saline, keep the patient as quiet as possible by means of bromides and morphia, and provide her with plenty of fluids and with bicarbonate of soda by means of intravenous infusions. Large doses of Lugol's solution, ʒvi or so, in saline, should be given by the rectum, or intravenously.

If it is noticed at the time of operation that one or more of the parathyroids have been removed by mistake, they can be replaced with some thyroid tissue round them and grafted into one of the muscles of the neck. A parathyroid graft may be performed at a later date if tetany sets in, though this is a very rare complication.

Usually after the operation improvement slowly occurs, but the patient must be kept quiet for at least four or six months, and is not likely to be completely recovered till the end of this period. All the signs and symptoms will improve, but the exophthalmos will be benefited least of all; the symptoms as a rule are more completely relieved than the physical signs.

There is some evidence that the toxæmia of this condition reaches its greatest height from six months to one year after the onset of the disease. Other things being equal, operation is better not performed during this period. In all severe cases there should be a preliminary rest in bed for six to eight weeks before the operation is undertaken and it is best not performed in hot weather. In very severe cases it is not always possible to remove as much gland tissue as one would wish to at the operation, and if this is so, it may be necessary to remove a further portion at a second operation later on.

Recurrent Hyperthyroidism. At times, some months or years after thyroidectomy a recurrence of symptoms is noticed. This may be due to an insufficient amount of gland having been removed, or if this is clearly not so, to some focal infection, worry, overwork, etc. If there still seems to be an excess of thyroid tissue in the neck, further removal should be undertaken. When, in spite of further operation even involving complete removal of all thyroid tissue, symptoms of hyperthyroidism still appear to be present, removal of one adrenal body has been performed with relief of symptoms.

Occasionally exophthalmos persists after operation and may even become more severe so that ultimately œdema of the conjunctiva and ulceration of the cornea set in and even total loss of sight may be threatened. When this is so relief may be obtained by *orbital decompression.* This is best done by elevating a frontal bone flap, lifting up the dura and frontal lobe and then removing the whole of the orbital roof.

Malignant Disease of the Thyroid. This gland is not an uncommon seat of malignant disease, and it is a particularly unfavourable situation for this to occur, as the gland capsule is rapidly penetrated and the trachea and surrounding structures soon implicated. The diagnosis is often difficult and the operative removal may be hazardous. Three varieties of malignant disease are seen in the thyroid :—

(1) **Carcinoma.** This condition usually develops in glands which are already the seat of parenchymatous enlargement, or of an old-standing adenoma. The growth is commonly of the spheroidal-celled type, and occasionally seems to have an alveolar aspect, the cells surrounding a definite lumen. They are sometimes divided into the two groups of scirrhous and papilliferous growths. The malignancy varies greatly with the amount of fibrous tissue present, some cases being highly malignant and soon extending into and ulcerating through the trachea. Metastases occur rapidly and early, the bones frequently being extensively involved. It sometimes happens that a secondary bone deposit is so big and prominent that it is the only thing noticed, and the existence of an enlarged thyroid may be overlooked; such bone deposits are often pulsating and have been mistaken for aneurysms.

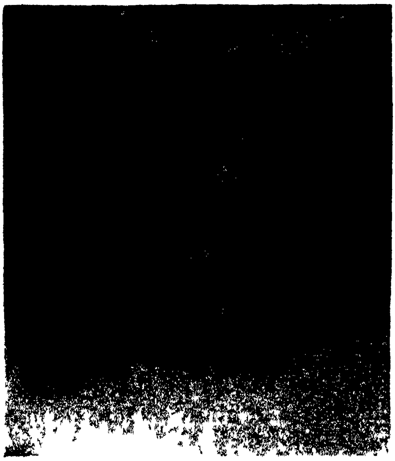


FIG. 152. Carcinoma of the thyroid. This case was inoperable.

(2) The so-called **malignant adenoma.** In this condition the thyroid gland itself may be enlarged hardly at all, while if it is increased in size its structure microscopically cannot be distinguished from normal thyroid tissue. The

local signs and symptoms are therefore negligible, but secondary deposits of growth also resembling normal thyroid tissue, and consisting of alveoli containing colloid substance, will rapidly occur all over the body, especially in the bones. In this case also the primary condition of the thyroid is exceedingly likely to be overlooked.

(3) **Sarcoma.** This is much less common than carcinoma and is usually of the small, round-celled type, occasionally spindle-celled. Clinically it resembles a soft carcinoma, but grows more rapidly and is more likely to be limited to one lobe of the gland.

None of these forms of malignant disease exhibits any marked tendency to involve the neighbouring lymphatic glands.

Malignant disease of the thyroid usually occurs in patients of either sex over forty, and though at times it is highly malignant, a few cases are seen (usually in rather younger patients) in which this feature is not marked and growth is comparatively slow.

Clinically a malignant thyroid gives rise to a stony hard, knobbly thyroid swelling, which grows rapidly and soon becomes fixed to surrounding structures, so that it will not move either across the neck or up and down on deglutition. The condition often supervenes upon a pre-existing parenchymatous goitre which has been present for some years, and when in a middle-aged patient a parenchymatous goitre suddenly starts to grow rapidly and becomes very hard in one part it is highly suspicious; in other cases the condition has started in a pre-existing cyst, which has suddenly got much bigger. Pressure effects come on early, the recurrent laryngeal nerves being soon involved (first the left one and then the right one as a rule), so that the vocal cords become paralysed and the voice hoarse. The trachea also is soon pressed upon, so that severe stridor is caused, while in other cases it will be found that the growth rapidly ulcerates through into the lumen of the trachea; and it must not be forgotten that such a growth at times will be firmly adherent to and even ulcerating into the trachea, and yet may move quite freely up and down and to and fro across the neck, carrying the trachea with it. Early involvement of the trachea may be shown sometimes in an X-ray film, as the outlines of the tracheal rings will be involved.

If it has ulcerated through into the trachea, however, there will be abundant bloodstained sputum and the trachea will be rapidly obstructed; thus stridor may be caused either by pressure from without, or in other cases by the ulcerating mass within the trachea. An important diagnostic point is that the tumour rapidly ceases to resemble the thyroid gland in shape, becoming more or less spherical and being covered by engorged and dilated veins. In the advanced stages the condition is most distressing, stridor is intense, and paroxysms of coughing are violent and frequent, while death usually occurs from suffocation, either sudden or prolonged. Occasionally bronchopneumonia or secondary hæmorrhage may terminate life before suffocation sets in. Some cases of malignant disease of the thyroid are accompanied by signs of myxœdema (see p. 408), and it has been observed sometimes that in such a case, when secondary deposits have occurred in the bones, the myxœdemic symptoms have disappeared. A few cases of malignant disease of the thyroid have been described with well-marked symptoms of Graves' disease.

It must be remembered that chronic thyroiditis (see p. 408) will resemble malignant disease closely; the former condition, however, gives rise to a hard, uniform enlargement of the gland which is not nodular or adherent to the surrounding structures, and only grows very slowly.

Treatment. This consists in complete removal of the half or the whole thyroid gland if possible, but it must be admitted that the majority of cases are inoperable when first seen. If attempted, it will be a difficult and dangerous operation, which may entail resection of a portion of the trachea or of any of the large vessels or nerves of the neck. It, of course, will be necessary to feed the patient upon thyroid extract after the operation for the remainder of his days. Occasionally in the case of a sarcoma which is confined to one lobe of the gland a hemithyroidectomy may appear to be sufficient.

In other cases, where removal is impossible, urgent operative measures may be necessary to prevent suffocation. Tracheotomy will prove difficult and dangerous, as the trachea will be buried under or pushed aside by large masses of growth, and it may be difficult to expose it; often it will be best rapidly to remove the central portion of the growth and thus expose the trachea, which then may be opened and a tube passed down it long enough to reach beyond the point where the obstruction occurs. This will produce a wonderful and immediate relief to the patient for a short time, but it will not be long before death from pneumonia or secondary hæmorrhage occurs.

Radium appears to have immediate, but unfortunately only temporary, effect on these thyroid growths.

In the case of malignant thyroid tumours where it is impossible to remove all the tumour it is probably best to remove as much of it as possible and then to give a course of treatment by means of deep X-rays. By this means some patients have survived a long time.

Acute Goitre. This is a very rare condition in which in young subjects a very rapid enlargement of the thyroid occurs and produces intense pressure upon the trachea, with urgent stridor. It is usually fatal unless relieved by hemithyroidectomy as soon as possible, the operation sometimes being one of great urgency.

Thyroidectomy in Cardiac Disease. Recently in angina pectoris, and still more in cases of congestive cardiac failure with failing compensation, complete thyroidectomy has been practised with a view to diminishing metabolism. This has caused considerable improvement in the patient's cardiac symptoms and general condition (see p. 461).

Diseases of the Parathyroid Bodies

The **parathyroid bodies**, four or more in number, lie just external to the capsule of the thyroid gland at the points where the inferior and superior thyroid arteries pierce it to enter the gland. In appearance they are small yellowish masses, usually about the size of a lentil and difficult to see.

Hyperparathyroidism. Recently, diseases of the parathyroid gland have come into prominence, for it has been shown that excess of parathyroid secretion causes loss of calcium from the bones and an excess of calcium in the blood. This is of importance, especially with regard to generalised fibrocystic disease of bone (osteitis fibrosa of Von Recklinghausen). This disease is described in Vol. I., Ch. XVIII., and is a progressive disease affecting multiple bones, causing softening, cyst formation, and at times benign giant-celled tumours, all of which give rise to pain, fractures and deformities. It differs entirely from osteomalacia, and from the localised form of bone cyst. These cases are usually definitely associated with a **parathyroid tumour**, of the nature either of an adenoma or of a hypertrophy. These parathyroid tumours cause a condition which may well be described as hyperparathyroidism, in which, in addition to the decalcification of bone above described, pain and tenderness are common and thirst and polyuria, renal calculus and renal colic occur. Hypotonicity of the muscles is seen, while wasting, abdominal cramps, nausea and vomiting occur. The blood-serum calcium varies between 12 and 23 mg. per 100 c.c., while the output of calcium in the urine is greatly increased.

In the presence of these signs and symptoms a tumour in the neck will frequently be found. If it cannot be felt, it is usually worth while exploring the neck and upper part of the chest, when a previously impalpable tumour is likely to be discovered. The local form of cystic disease of the bones does not appear to be associated with parathyroid changes.

Treatment. Removal of the parathyroid tumour should be undertaken and rapid improvement is likely to follow. It has even been stated that renal calculi commence to break up after it. The operation should be followed by a high calcium diet and ultraviolet light. If tetany should set in after the operation, injections of parathormone should be used in combination with calcium. With regard to the operation, a wide incision must be made as it may be necessary to look at all four parathyroid bodies, and even to examine the upper part of the mediastinum. A parathyroid tumour has usually a characteristic yellow brown colour.

OPERATIONS ON THE THYROID GLAND

Thyroidectomy. In many cases the operation of thyroidectomy is really a hemithyroidectomy and consists in the removal of one lobe of the thyroid only. This is especially the case when it is performed for parenchymatous goitres or large adenomata. In the case of Graves' disease, however, a hemithyroidectomy is never sufficient, and it is then necessary to remove one lobe, the isthmus, and the greater part of the other lobe.

The operation is performed as follows : The incision is usually known as the collar incision. This is from 3 to 5 inches in length, according to the size of the neck and of the goitre, and runs practically straight across the neck with the slightest possible bend downwards. It should never be a flap or U-shaped incision, as the scar produced by the collar incision is infinitely less noticeable. The skin is then extensively undercut downwards to the sternum and suprasternal notch and upwards to the level of the top of the thyroid cartilage. There may be many bleeding points in the subcutaneous tissue, and they are all picked up and tied with catgut. A vertical incision is then made down the midline through the deep fascia, passing from just below the thyroid cartilage to just above the sternum, and the sterno-hyoid and sterno-thyroid muscles on the two sides are separated from each other in the midline. The muscles on the side on which the lobe is going to be removed are widely retracted and incisions are carefully made through successive layers of fascia until the actual surface of the thyroid gland is exposed. It is most important that the right plane of tissue should be reached, and this is not easy to do. A finger is then inserted and the upper part of the lobe to be removed is set free. In many cases this procedure will be made much easier if the sterno-hyoid and sterno-thyroid muscles on the one side are cut across, and in the case of big goitres or adherent and vascular exophthalmic cases there is no objection to doing this. The section of the muscles, however, should be made high up near the thyroid cartilage, as their nerve supply will then not be interfered with. The apex of the upper lobe is reached and dragged downwards, and in exophthalmic cases it may be very high up. The superior thyroid artery and veins will then be brought into view, though they often do not enter the gland right at its apex. These vessels are clamped in two places and cut in between the clamps. The gland is then turned forwards so that a retrolaryngeal lobe, if present, may be brought out. The lower pole of the lobe is then exposed and lifted up, and by dragging the cellular tissue and fascia off it with a blunt dissector the inferior thyroid artery will be seen, while the recurrent laryngeal nerve which breaks up into several branches just before entering the larynx, will be found to be closely applied to this. The artery is clamped and cut, and the nerve carefully preserved. The back part of the gland has then to be set free from the trachea, and this will have to be done by snipping with the scissors, as there is a small area where the two structures are intimately adherent. The isthmus is then set free and the lobe turned over to the opposite side. If this is all that is to be removed the isthmus is crushed and tied and the lobe taken away. If, however, as in exophthalmic cases, it is desired to remove more thyroid tissue, the lower pole of the opposite lobe is gently set free and lifted up with the fingers. The portion to be removed, which may vary from an eighth to a half of the remaining lobe, is then isolated by curved artery forceps, clamped upon the gland successively, and as each pair of forceps is clamped on, the corresponding piece of gland is snipped across with curved scissors. All the bleeding points are then tied, and in the case of hard, friable, exophthalmic glands, the greatest care is necessary in tying those forceps which are upon the cut surface of the gland. The wound is rendered as dry as possible, and washed out with hot saline, and the vertical incision through the fascia and down the midline is sutured with catgut. A small tube is introduced through a separate stab incision in the skin, and this passes down beneath the deep fascia; the skin is sewn up with the finest salmon gut.

After-treatment. The patient is propped bolt upright in bed and given nothing but cold fluids for the first twenty-four hours, as hot drinks are liable to cause hæmorrhage. After this she can have anything she can swallow. Small quantities of morphia or heroin may be given if necessary, while the soreness and huskiness of the throat will be relieved considerably by the following linctus :—

Morphia	gr. ss
Apomorphin	gr. $\frac{1}{12}$
Atropin	gr. $\frac{1}{100}$
Syr.: limon:	ʒi
Aq.: chloroformi	ad ℥i

Sig. ʒi six times in twenty-four hours.

The tube and all stitches are removed in forty-eight hours. If this is done they will leave no marks.

In the case of exophthalmic goitres the after-treatment is similar, save that here it is all-important to provide the patient with plenty of fluid (best given by the rectum), and to keep her absolutely quiet, this being best achieved by large quantities of bromide, while the Lugol's iodine, ♏ x t.d.s., may be continued for a fortnight. Should the complication of hyperthyroidism supervene, she must be given fluid in every possible form with as much bicarbonate as possible, and morphia and other drugs must be given to prevent her being restless, while the rectal, intravenous or intramuscular injection of large doses of sterile Lugol's iodine solution is much used on the Continent and has some success. Little good follows opening up the wound and washing it out, though this may be tried (see p. 421).

Enucleation of Adenomata. Small adenomata in the gland may be removed by enucleating them. In this case a small vertical incision is made over the adenoma, and the skin, deep fascia and muscles are incised until the gland is exposed. The gland is then incised and the adenoma discovered. It will appear smooth and bluish-white. It can then be shelled out of the gland with a blunt dissector, all bleeding points are tied and the gland tissue is drawn together with a few catgut stitches. The wound is then closed. This operation is by no means as easy as it sounds and hæmorrhage may be troublesome.

Resection-Enucleation of Adenomata. This operation is a better procedure than the last, especially if the adenomata are large or multiple. Very large adenomata which occupy the greater part of one lobe are best treated by hemithyroidectomy.

In resection-enucleation the adenoma and the portion of gland tissue round it are exposed by a vertical or oblique incision passing through the skin, fascia and muscle down to the gland. The portion of the gland concerned is then set free and the adenoma, together with about ½ inch of gland tissue on all sides of it, is excised, the gland being clamped by a successive application of curved artery forceps, and the required part being snipped away with scissors. All bleeding points are tied and the wound is closed. It is usually wise to put a tube in for forty-eight hours, as otherwise a hæmatoma may form.

After operations upon the thyroid gland, tetany is very rare indeed. It is more common after gastric operations.

CHAPTER XI

THE CHEST

Surgical Anatomy and General Considerations. The junction of the manubrium and body of the sternum is marked by a prominent ridge (angle of Ludvig), which is opposite to the second costal cartilage and at the level of the fifth dorsal vertebra. The upper and lower edges of the sternum correspond to the disc between the second and third thoracic vertebræ and the ninth thoracic vertebra respectively. The first rib lies almost entirely under cover of the clavicle, though its anterior few inches, which are cartilaginous, can be palpated below the sternal edge of this bone.

The internal mammary artery passes down half an inch external to the outer border of the sternum and bifurcates opposite to the sixth costal cartilage. It lies behind the costal cartilages and the intercostal muscles.

The intercostal vessels and nerves lie in a groove on the under and inner aspect of the ribs except in that part of their course which is behind the rib angles. Here they cross the intercostal spaces obliquely and are liable to injury. Incisions in the intercostal spaces should, therefore, be made near the upper border of a rib. It must not be forgotten that the apex of the lung extends about 1½ inches above the middle third of the clavicle under the clavicular head of the sternomastoid muscle, when the patient is erect. The pleura reaches its lowest point in the mid-axillary line, it being here situated about 2 inches above the costal margin. The lower border of the lung lies about two fingers' breadth above the pleural reflection, the main fissure of each lung being represented by a line starting from the second dorsal spine and crossing the fifth rib in the mid-axillary line to end at the lower border of the lung, opposite the sixth chondrocostal junction. The heart lies behind the third, fourth and fifth costal cartilages and that portion of the body of the sternum which corresponds to these.

Intrathoracic Pressure. On opening the thoracic cavity on one or other side the lung on that side collapses and a pneumothorax results, while the mediastinum is drawn over to the opposite side and impedes the action of the other lung. Should this happen on both sides respiration is, of course, impossible. To avoid the possible but exaggerated danger of a sudden one-sided pneumothorax during thoracic operations, various forms of differential pressure apparatus have been devised—

1. Negative pressure apparatus, in which the patient's chest and the surgeon and his assistant are enclosed in a chamber with negative pressure, while the patient's head and the anæsthetist are outside in normal atmospheric pressure.

2. Positive pressure apparatus in which the patient's head is enclosed in an air-tight chamber or mask by means of which air (and anæsthetic) is supplied to him at a pressure slightly above that of normal atmospheric pressure. Both these forms of apparatus are expensive, inconvenient and cumbersome, and they have now been almost completely replaced by

3. The intratracheal method of administering ether or gas, in which the anæsthetic is pumped into the chest through a catheter passed down into the trachea, under a pressure greater than atmospheric. This serves to keep the lung completely expanded if so desired, while the chest is open, and obviates any danger of pneumothorax, whilst the apparatus is simple and compact. The pump employed may be worked by the anæsthetist or driven by an electric motor.

More recent experience has shown that at any rate one pleural cavity can be opened and operations performed upon the heart and lungs, with safety, without any differential pressure apparatus at all, under ordinary methods of anæsthesia, but if this is done it is important to prevent the mediastinum being flapped from side to side by the respiratory movements. There can, however, be little doubt that for elaborate intrathoracic operations, with the possible exception of those performed on phthisical patients, the intratracheal method is by far the most satisfactory.

Thoracoscopy. By means of the thoracoscope, which is an instrument very similar to the cystoscope and which is introduced into the pleural cavity after an artificial pneumothorax has been treated, the greater part of the pleural sac can be seen and examined and pleural adhesions can if necessary be cut. Several different forms of instrument are available (see p. 454).

INJURIES OF THE CHEST

In this connection, as in the case of the skull and brain, we have to consider injuries of the chest wall and thoracic parietes and the injuries of the thoracic viscera, remembering that any form of injury of the chest wall may coexist with any variety of damage to the viscera inside, and that there may be severe injuries to the thoracic viscera without any lesion of the parietes. Occasionally severe shock (see Vol. I., Ch. IV.) and even death may follow the insertion of an aspirating needle or a blow on the chest, especially in the neighbourhood of the heart or diaphragm, while no lesion may be discoverable on examination (**concussion of the thorax**). This condition of intense collapse following a blow on the chest (*commotio thoracis*), which may lead to death, is comparable to concussion of the brain, the patient falling apparently lifeless.

Injuries of the Chest Wall.

Contusions. These are common occurrences and are produced by blows, crushes, falls, or "run-over" accidents. Shock and collapse are often present, while extensive extravasations of blood in the connective tissues and muscles over the back or pectoral regions are often found ; if this is so laceration or rupture of muscular fibres has very probably occurred. The part struck is bruised and very tender, while coughing, sneezing or breathing may cause sharp pain, and the condition thus may resemble a fracture of a rib (see p. 429). Children often suffer less pain from such injuries than do adults, for their ribs and sternum are more elastic and their chest more rounded, but they are also, for the same reasons, more liable to receive severe intrathoracic injuries without external signs. After such an injury the respiration may be unusually rapid for several days, whilst it is frequent after forty-eight hours to find a **traumatic pleurisy** with a distinct pleural rub audible under the injured part of the chest wall. These contusions owe their chief importance to the fact that they are so often associated with visceral injuries. It must not be forgotten that in elderly patients injuries of the chest wall and, indeed, injuries elsewhere in the body are very liable to be followed by pneumonia. In children scalds, especially of the chest wall, often give rise to broncho-pneumonia.

Treatment. This consists in combating the collapse, rest in bed, and the application of cold dressings and firm bandaging (see p. 430). After a few days, gentle massage will give relief.

Traumatic Asphyxia. Severe and prolonged compression of the chest, such as may occur in crowds or in patients crushed under weights, with or without injury to the thoracic wall or contents, may cause suffusion of the face, head, neck and eyes with blood, the face and neck down to the clavicles being puffy, swollen, and of a deep blue-black colour. Bleeding from the nose and pharynx and unconsciousness may occur. This discoloured area is sharply defined and on close inspection is seen to be punctate ; the discoloration does not disappear on pressure, while the patient's features may be unrecognisable. The condition only occurs in young people, as it is only in such persons that the thoracic walls are sufficiently elastic not to receive severe damage. Any small amount of support given to the walls of the capillaries is sufficient to modify the suffusion of blood, so that the hat may be sufficient to prevent the discoloration occurring above where the brim presses on the scalp, and the light pressure of the collar, or of a pair of spectacles on the nose, may produce a sharp line where there is no discoloration. Œdema of the eyelids and conjunctiva occurs, and at times temporary blindness, or even permanent optic atrophy. There may be temporary loss of consciousness, but cerebral or meningeal hæmorrhages have never been found post-mortem. Sublingual hæmatomata and conjunctival hæmorrhages are seen, while the condition is thought to be caused by over-distension of the veins and capillaries due to the absence of functioning valves in the jugular, facial and other cranial veins. Actual extravasations of the blood into the tissues outside the capillaries does not occur. The dark colour fades in a few hours and in four days will have disappeared.

Treatment. The condition, though alarming, is not serious, unless associated with visceral injury, though shock may be severe. The treatment is that of any associated injuries, but it must be remembered that the condition may be followed by pneumonia.

Wounds of the Chest Wall. These may be penetrating or non-penetrating; if not penetrating, they are not serious and do not differ from wounds in any other part of the body (see Vol. I., Ch. IV.). Occasionally, however, even though no communication exists with the inside of the thorax, surgical emphysema of the tissues for a short distance round will be found, the air having been sucked in by the respiratory movements. A similar condition is occasionally seen on the abdominal wall, and round wounds near the elbow and knee, the movements of the limb sucking the air in.

Penetrating wounds are far more serious, as they are usually accompanied by wounds of the intrathoracic organs (*q.v.*).

FRACTURES OF THE RIBS AND STERNUM

Fracture of the Ribs. This is a common accident and occurs in three ways:

(*a*) As a result of direct violence from blows applied to the rib itself. When due to a violent blow, the ribs give way at the point struck, and the fragments probably will be forced inwards so as to damage organs in either the chest or the upper part of the abdomen. Such fractures are occasionally compound, though this latter type is usually rarely seen except in gunshot wounds.

(*b*) From indirect violence, as when the chest is crushed by being run over or other accidents of this type. This is much the most frequent cause. The ribs yield under their natural elasticity up to a certain point, finally breaking at their most convex part, which is near the angle. The injury may affect one or more ribs, but those most commonly affected are between the fourth and eighth, and it is usual to see more than one fractured. The sharp, broken ends are usually turned outwards, so that injuries to the internal viscera are unusual, while in severe accidents the fracture will be rendered compound by the sharp ends sticking out through the skin. The floating ribs usually escape on account of their mobility, while the first and second ribs are rarely broken, as they are protected by the clavicle.

(*c*) From muscular action. A fractured rib as the result of a muscular effort, usually coughing, sneezing, or straining, is occasionally seen. The damage is usually confined to one rib and affects the anterior half, there being no displacement.

There are certain general conditions which render the ribs specially liable to fracture, old age, insanity, especially general paralysis of the insane, rickets, mollities ossium and general wasting diseases being the commonest.

Clinically the patient probably will feel a snap at the moment of fracture, and this is followed by an exceedingly sharp, localised, catching pain at the site of the injury on coughing, sneezing, or breathing deeply, so that the breathing becomes shallow and rapid. Local extravasation and swelling are not usually seen; tenderness will be detected in two ways, either by pressing upon the site of the fracture, or by pressing the sternum towards the spine so as to compress the chest. Crepitus is sometimes detected when the patient coughs or breathes deeply, while if not felt, it may be heard with the stethoscope. If several ribs are damaged a marked depression may be detectable, but in many cases, especially in stout individuals, the diagnosis will be problematical. An X-ray photograph may show a fracture, but cannot be relied upon to do so always.

It must be remembered that this injury is frequently associated with any of the injuries to the thoracic viscera described on pp. 431–439, and it must be remembered also that every case of fractured ribs is followed by a certain degree of traumatic pleurisy, while it is by no means uncommon for some degree of hæmothorax to develop as the result of laceration of the pleura. Hæmothorax, therefore, does not necessarily imply injury to the lung.

Firm union always occurs, but there will be a considerable amount of callus, especially on the inner aspect of the rib, and this is liable to cause severe pain for months afterwards should it involve an intercostal nerve.

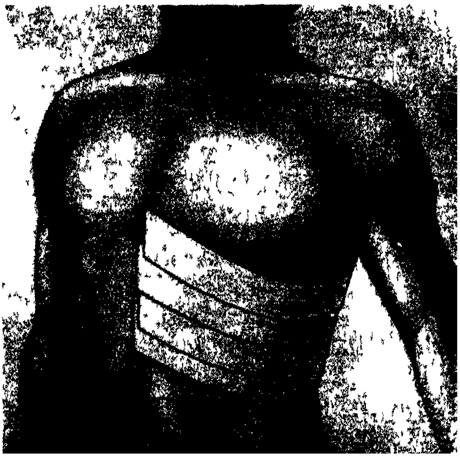


FIG. 153. The method of strapping the chest for a fractured rib.

A few cases of fractured ribs have been recorded which have been followed within a few days by severe paralytic ileus (see p. 696), necessitating enterostomy for its relief. This is sometimes accompanied by an unusual melancholic mental attitude; the cause of this complication is not known for certain, but it may be the results of irritation of the sympathetic by the broken rib ends.

Treatment. The first essential in treatment is to ascertain whether intrathoracic injuries are present; if so, they should be treated as described on pp. 431–439. In uncomplicated cases the patient should be put to bed if suffering from shock or if several ribs are broken, and the movement of the damaged side of the chest must be controlled as far as possible by strapping. Broad strips of sticking plaster, at least 2 inches wide and extending beyond the midline both at the back and front of the chest, should be applied from below upwards; they must be made to overlap each other, and each strip must be applied with the chest as far as possible completely emptied of air (see Fig. 153). This may be covered conveniently with a firm woollen bandage, and should be worn for three and a half weeks. In some cases this will not relieve the pain, and then it may be necessary to strap both sides of the chest so that the patient breathes with his diaphragm alone. In other instances, especially where the ribs are driven in, strapping is painful and unwise, as it may drive the bone ends in further still. In this case no support is given to the chest, but the patient must stay in bed with the arm bound to the side and a sandbag placed between the shoulders.

Dislocation of the Ribs and Costal Cartilages. At times the costal cartilages are separated from the rib ends, while a cartilage actually may be fractured itself, this latter condition being much more common in patients over the age of sixty-five ; in both these cases union occurs by bone. The clinical features and the treatment are the same as in the case of fractured ribs.

Occasionally, as the result of severe forms of violence, the rib ends may be dislocated from the vertebræ or the cartilages from the sternum ; in nearly all these cases severe internal injuries will be present also.

Fracture of the Sternum. This fracture may be due to direct violence from a blow upon the bone, but in most instances it is the result of indirect violence as the result of forcible extension or flexion of the body. In nearly all these cases it is accompanied by a fracture of the spine, and it is probable that in this connection it is much more common than is suspected. Such a fracture is usually transverse, and near the junction between the manubrium and the gladiolus. Usually there is no displacement, while in other instances the upper portion passes backwards behind the lower. Should this occur, the prominence and deformity are very noticeable, but if there is no displacement, pain and a small effusion of blood may be the only detectable features. All movements are painful, respiration is rapid, and the head is held rigidly forwards. Dyspnœa or stridor will occur sometimes, either as a result of the bony displacement or from an effusion of blood into the mediastinum. Injuries to the thoracic viscera are usually present also.

Occasionally the xyphoid process is driven inwards off the body of the sternum, and causes pain, vomiting, dyspnœa and abdominal rigidity.

Treatment. The patient must be kept in bed with a firm pillow between the shoulders ; if there is overlapping this may be reduced by bending the body backwards provided no fracture of the spine is present. Otherwise, or if there is no deformity, the chest should be strapped as for fractured ribs. If the displacement is irreducible and causing dyspnœa, it may be necessary to cut down upon the fracture, elevate the fragments into position and fix them, but it should be remembered that union with deformity is not serious and gives rise to very little inconvenience.

Displacement of the xyphoid process usually will require operation to relieve the pain and discomfort ; the process should be removed.

INJURIES OF THE THORACIC VISCERA

The structures which are liable to be injured are the lungs, pleura, heart, pericardium, and occasionally the great blood vessels. In order to ascertain which, if any, of these viscera are damaged, a careful examination of the whole thorax should be made, employing the ordinary methods of palpation, percussion and auscultation. Special observation should be given to the position of the heart's apex beat, the presence of signs indicating damage to the thoracic wall (see pp. 428–431), and also any traces of hæmoptysis, hæmothorax, pneumothorax or surgical emphysema. X-ray films also will be of great assistance, for in addition to indicating the presence of bony damage, a more exact determination may be made by this means of the position of the intrathoracic viscera, the presence of fluid and the movements of the diaphragm. A hæmothorax or hæmatoma will show up especially clearly in an X-ray film.

(It must not be forgotten that any form of injury to the intrathoracic viscera may or may not be associated with any variety of damage to the thoracic wall.)

Injuries of the Lung. These may be contusions, lacerations or penetrating wounds. A contusion of the lung is usually associated with a minor degree of injury to the thoracic wall, often not severe enough to fracture the ribs. The symptoms are a mild degree of shock, slight cough and hæmoptysis and severe pain in the side, while after a few hours a pleural rub will appear, pointing to the development of a traumatic pleurisy. There may be also some dulness on percussion, which will indicate that the lung underneath is in a state of engorgement. A local extravasation of blood will occur into the tissues and alveoli of the lung, and this is followed by a mild inflammatory reaction and the production of a small area of consolidation.

The condition is not serious, and the treatment consists in absolute rest, small doses of morphia if necessary, and strapping to the side.

Though the primary contusion is not severe, it must be remembered that the damage done to the lung and the bronchioles, and the alteration of their blood supply, permits the penetration of organisms into the damaged tissues. There is always, therefore, some liability for the injury to be followed by pneumonia or even abscess of the lung.

Laceration of the Lung. This condition is associated nearly always with a fracture of one or more ribs, and in many cases it is the sharp end of a rib which actually damages the lung. The extent of this damage to the lung varies enormously, and there will be a corresponding variation in the severity of the symptoms, but in all cases the damaged and infiltrated lung tissue is certain to have its resistance against infection lowered. Mild cases are virtually the same as the condition of contusion of the lung described above, but in the more severe cases there will be marked shock and collapse, intense pain and dyspnœa. The wounded lung bleeds freely and blood, often accompanied by air, pours into the pleural cavity ; this causes the lung to collapse and may stop the hæmorrhage. In most cases there soon will be hæmoptysis, the patient complaining of an irritating cough and bringing up quantities of frothy blood, and if one of the larger pulmonary vessels is injured this hæmoptysis may be so severe that the patient actually will die soon from loss of blood. A **hæmothorax** often will be caused and give rise to the classical signs of fluid in the pleura, within a few hours, the amount of blood effused varying from a few ounces to several pints. The signs to which this gives rise are displacement of the heart's apex beat, a gradually increasing area of dulness spreading from below upwards, absence of breath sounds and vocal fremitus, with marked ægophony. There always will be marked dyspnœa, but the dulness is not usually as intense as in a pleural effusion because the blood is frothed by bubbles of air in it. Constitutional signs of hæmorrhage will be present (see Vol. I., Ch. IV.), and the temperature may or may not be raised, frequently being found to be sub-normal. In some cases the blood in the pleura has come from an injured vessel in the chest wall and not from the damaged lung. This hæmothorax, if large, may be sufficient to cause the patient's death from interference with the function of the heart. Should the patient recover, the hæmothorax will be absorbed gradually, though it will leave in its train pleural adhesions and a markedly thickened pleura. While present, however, it is liable at any time to become infected and give rise to an empyema. Occasionally such an effusion of blood into the pleura does not occur during the first few hours after the injury, owing to the lowering of the blood pressure from shock: in this case it may appear with dramatic suddenness later on.

In addition to blood escaping from the damaged lung, air may do so likewise and be found in the pleural cavity, where it causes the condition of **Pneumothorax**; in many cases air also passes into the cellular tissue under the skin, giving rise to the peculiar crackling feeling known as Surgical Emphysema (see below). The pneumothorax will be associated with a certain amount of collapse of the lung, and this, if sudden or severe, leads to considerable dyspnœa and interference with the heart's action. Such a pneumothorax, though it is indirectly connected with the bronchi, does not, as a rule, become infected, provided that the lung previously was healthy and that it is not accompanied by a hæmothorax. In some cases the opening from the lung into the pleura is of a valvular nature and permits the air to pass out of the lung into the pleural cavity, but does not permit it to pass in the reverse direction. In this case, owing to the pumping effects of the patient's respiratory movements, the pneumothorax will increase steadily in size, the pressure becoming greater and greater within it, and the heart and mediastinum becoming more and more displaced. This condition is known as an **Ingravescent Pneumothorax** and demands instant relief. The symptoms and physical signs of a pneumothorax are severe pain, dyspnœa and cyanosis, with displacement of the apex beat to the opposite side, increased resonance all over the lung, absence of vocal fremitus, absence of breath sounds or amphoric breathing, and in some cases metallic tinkling, or "bell sound." Most frequently blood as well as air will be present in the pleura, the condition then being known as a **Hæmo-pneumothorax.** In this case there will be a combination of the signs of hæmothorax and pneumothorax, while in addition, on shaking the patient, a splashing sound may often be heard. As the wound in the lung heals, the air will disappear gradually from the pleura, and in the course of four or five days, provided no large quantity of blood is present, the lung will re-expand.

Surgical emphysema over the chest wall, which is due to air escaping from the lung, gives rise to a flattened, painless, diffused swelling, with a hyper-resonant note on percussion and causing a peculiar crepitant feeling on palpation: it usually starts in the neighbourhood of the injury. In the rare cases where it is due to a rupture of the lung near its hilum, without any damage to the parietal pleura and thoracic wall, it will appear first at the root of the neck or in the suprasternal notch, but in most cases it is evidence that both the visceral and parietal layers of pleura are damaged. In either case it may spread far and wide, frequently involving the whole trunk and the neck and face. In itself it is not serious, excepting so far as it shows that the lung is damaged, and if the patient recovers from his lung injury, it will soon disappear (see p. 436, Ruptured Bronchus). A few days after such an injury to the lung a traumatic pneumonia or pleurisy associated with a rise of temperature may set in (see also pp. 443–447).

Penetrating Wounds of the Lung. These are due to a direct injury, such as a stab-wound or gunshot-wound. The signs and symptoms will be very similar to those of laceration of the lung, but in this case we have the additional presence of an external wound penetrating the chest wall. There will be, therefore, more or less external hæmorrhage always, and this may come from an artery in the chest wall, such as an intercostal artery or the internal mammary, while in other cases it will come from the wounded lung itself, or even from a large damaged vessel within the thorax. It may be very severe, therefore, and lead to a rapid death from hæmorrhage. Air will escape through the external wound and may be sucked in and out with the respiratory movements, and thus the occurrence of an extensive hæmothorax or severe surgical emphysema is less likely. The wound also provides an entrance into the chest and lung for infection, and the condition is often complicated by the presence of a foreign body, such as a bit of shell, pieces of clothing or other septic material. A severe intrathoracic infection will be a frequent sequel, and this in many cases will lead to the onset of septic pneumonia, gangrene, abscess of the lung, or empyema. Should there be a large external wound in the thoracic wall, allowing very free entrance of air, the lung and mediastinum may flap backwards and forwards during the respiratory movements, as air is sucked in and out through the wound, and this will lead to great shock and interference with the heart's action. In such a wound it is, of course, likely that other viscera besides the lung will be damaged ; the pericardium, heart or great vessels may be involved, while not infrequently the diaphragm will be injured and some of the abdominal viscera be wounded as well, and this is especially the case in gunshot wounds. If the left side of the diaphragm is injured and the patient recover, the condition probably will be followed by a diaphragmatic hernia, but this does not usually occur on the right side, as the presence of the liver will prevent it (see p. 462, Diaphragmatic Hernia).

In all cases an X-ray photograph should be obtained.

Treatment. The treatment of these conditions depends largely on whether there is an external wound in the thorax or not, but in all cases we are guided by three great principles—the counteraction of collapse, the arrest of bleeding, and the prevention of infection. The cases most commonly seen in civil practice, where the lung is damaged without an external thoracic wound, do not often require immediate operation. If the lung is free to collapse within the pleural cavity, it is most probable that bleeding will stop, but if part of the lung is fixed by adhesions due to old disease, collapse cannot occur, and then operative interference to stop the hæmorrhage is more likely to be required. Shock and collapse are present to a varying degree, and, therefore, may require appropriate treatment (see Vol. I., Ch. IV.). In addition to this, the chief indication in the first twenty-four hours is to stop bleeding from the lacerated lung, relieve pain, and prevent any undue distress of the heart's action. This is best obtained by absolute rest, the patient being kept in bed in a quiet room, with a low diet and with the injured portion of the chest strapped. Should there, however, be such severe fractures of the ribs that strapping might force their sharp ends inwards into the lung, it had better not be employed. Ice should be given to suck, and it is possible that the hæmoptysis will be benefited by the administration of ergot, either in a mixture by the mouth or injected hypodermically in the form of ergotin. But the chief drugs for controlling the hæmoptysis and the hæmorrhage are heroin and morphia, and these, at the same time, will relieve the pain and benefit the shock. Stimulants must be avoided, as they may increase the bleeding. A close watch must be kept upon the extent of the hæmothorax, if present. It must be remembered that blood extravasated into the pleural cavity does not form a solid clot, but fibrin will be deposited in layers over both pleural surfaces, and this in course of time will give rise to pleural adhesions and thickened pleura, thereby preventing proper re-expansion of the lung. Therefore, though a very small hæmothorax may be left in situ, in the hope that it will reabsorb, a moderate or large hæmothorax, or one which is not showing obvious signs of decreasing in size after a day or two, should be aspirated, but it is wise not to undertake aspiration until the third day, that further hæmorrhage may not ensue. The blood withdrawn should be examined bacteriologically, and if it is found to be infected a thoracotomy to drain the thorax almost certainly will be necessary, as the condition is virtually one of empyema (*q.v.*). If the blood cannot be withdrawn by the aspirating needle, drainage also will be necessary. The type of *thoracotomy* performed to drain a large hæmothorax of this kind should not consist in simply making an opening and inserting a tube. A long incision should be made over whichever rib appears the most suitable, and 3 or 4 inches of the rib removed. A rib-spreader should then be introduced, such as Tuffier's rib retractor, and the ribs stretched apart sufficiently to allow the whole hand to be introduced into the pleural cavity. All blood clot can then be cleared out, and the lacerated lung sutured if necessary: if it is still bleeding, this should control the hæmorrhage, and any vessel in the thoracic wall can be similarly controlled. At the end of this operation it is most important that the chest should be completely closed by suturing the wound layer by layer without drainage, as in this way shock will be avoided, both respiratory and cardiac distress relieved, and rapid re-expansion of the lung encouraged. After suture of the wound re-expansion of the lung will be further assisted by withdrawing the air from the pleural cavity by aspiration or by replacing it with oxygen. It must not be forgotten that after this operation infection of the pleural cavity may still develop. If this infection is due to a streptococcus or appears to be virulent, the wound had better be reopened and drained at once, but in other cases one or more aspirations may be all that is necessary. The presence of a pneumothorax by itself will not demand operative treatment unless it is of the ingravescent type; in this case the increasing intrapleural pressure will demand relief as soon as possible, and this will be obtained best either by aspiration of the air or by oxygen replacement. Occasionally cases will be met with in which there is an intense temporary dyspnœa, which is not due to any gross discoverable cause, such as a big hæmothorax or pneumothorax. In this case diminution of the blood pressure may relieve the distress of the heart and uninjured lung, and if this cannot be obtained sufficiently by means of drugs, venesection often will give relief.

In the case of penetrating wounds of the thorax and gunshot wounds, operation will be needed far more frequently. In those patients where the lung is flapping about, owing to a large opening in the thoracic parietes, immediate closure of this opening by suture will relieve collapse and distress greatly, and tend to diminish the amount of hæmorrhage. Even though infection is almost certain to follow, it is wise in such a case, if necessary, to form a flap which will close this opening completely and suture it into position so as to be as far as possible airtight. If this cannot be done the wound must be blocked up with large pads of dressing. After a few hours, when the immediate danger of shock and hæmorrhage is over, a more radical operation may be necessary. The wound can then be reopened, excision of ragged skin edges and tissue performed, the pleural cavity freely exposed, blood clot turned out, foreign bodies removed, and the lung drawn up and examined. Torn fragments of lung may be excised and the remaining wounds in it sutured, and in this way bleeding will be controlled and expansion of the lung encouraged. The wound in the chest wall finally should be sutured in layers without drainage and the air contained in the pleural cavity removed by aspiration. Infection may occur at a later date, in which case aspiration or drainage may then become necessary, but in a great many cases healing by first intention will be obtained.

Complications following Injuries of the Chest and Lung. These may be immediate or remote. The two commonest complications are septic pneumonia, which is a grave condition and should be treated on ordinary medical lines, and empyema (see pp. 442–447). It is important to realise that fever in cases of injury to the lung does not necessarily mean suppuration, or even infection. For it may be due to absorption of sterile disintegrated tissue, or to tissue reaction following irritation. Incomplete expansion of the lung not infrequently results, and is due to the formation of adhesions and pleural thickening ; it may in its turn lead to falling in of the chest wall with marked deformity or the formation of a sinus which will not heal. For its treatment, see p. 448.

Hernia of the Lung (Pneumatocele). This is a rare condition, which sometimes follows injuries of the chest wall, and may occur either rapidly, owing to damage to the intercostal muscles or ribs, or more gradually, due to the yielding of scar tissue. In some cases the hernia protrudes through a congenital defect in the chest wall. It is due to a portion of the lung, usually the thin edge, protruding through the chest wall under the skin, and is seen either at the apex of the lung in the root of the neck or in the mid-axillary line at the fifth or sixth intercostal space. A hernia occurring at the root of the neck is sometimes not associated with any injury, and is seen in emphysematous patients. It gives rise to a soft round swelling, highly resonant on percussion, with a marked impulse and increase in size when the patient coughs or strains. When squeezed it gives a crepitant or crackling feeling, and on applying the stethoscope loud respiratory sounds are heard. The patient frequently complains that it causes an irritating cough. If it is small and easily controlled by a pad or support, this will be all that is required, but if this proves unsatisfactory, and the condition still gives trouble, an incision should be made over the swelling, the lung freed and pushed back into the chest, and the opening in the thoracic wall closed by means of a flap of muscle or fascia. In some cases a rib may be split down its long axis, and its outer surface with the periosteum attached turned over to close the gap.

Prolapse of the Lung occurs as an immediate complication of an open wound of the thorax ; the lung tissue can be recognised protruding through the wound. Apart from the risk of infection, it is not necessarily serious, as it may prevent collapse of the lung and pneumothorax. If not treated the lung is liable to become gangrenous from strangulation, and an effort must, therefore, always be made to reduce the lung within the thorax and close the opening. If the prolapsed portion becomes gangrenous it should be ligatured and excised.

Rupture of a Bronchus. This is a rare accident and is probably due to violent displacement of the mediastinum, tearing a primary bronchus across. Such a laceration is extrapleural and gives rise at once to an intense mediastinal emphysema, accompanied by much shock. This is a most dangerous condition, as the compression of the structures in the mediastinum by escaping air produces progressive dyspnœa, cyanosis and distension of the veins of the face and neck. There is a tympanitic note over the sternum, and the surgical emphysema appears later at the root of the neck, thence spreading far and wide (see p. 433).

Treatment. A ruptured bronchus is a most grave condition and demands immediate operation for suture. As a preliminary and to relieve the distress an incision may be made above the suprasternal notch, and suction applied here in an attempt to withdraw some of the air from the mediastinum.

The operation is similar to that of trans-mediastinal bronchotomy for removal of foreign bodies. The bronchus is approached by turning out a flap containing the posterior parts of ribs five, six, seven, and eight, the flap having its base along the vertebral border of the retracted scapula and its free border along the tips of the transverse processes. The pleura and lung are pushed outwards and forwards and the bronchus exposed. The rupture must then be sutured with catgut sutures and the wound closed with efficient drainage of the mediastinum.

Foreign Bodies in the Lung. Bullets or fragments of metal often will be found imbedded in the lung years after a wound was received. They are often near the surface of the lung, and, though in some cases they may cause no symptoms, it is more common for them to give rise to pain, dyspnœa and cough, mental anxiety and not infrequently hæmoptysis. They usually will be accompanied by much scarring and induration of the lung and pleural tissues round. After accurate localisation by means of X-ray films, if the foreign body is causing symptoms, it should be removed by thoracotomy and exploration of the lung.

Foreign Bodies in the Bronchus. (See p. 368.)

INJURIES OF THE HEART AND GREAT VESSELS

Wounds of the great vessels, whether produced by stabs, gunshot or crushes, are almost invariably fatal, and there is little prospect of operation being possible.

Rupture of the Heart is rare. It has been described as occurring spontaneously without any injury to account for it, and at other times it has occurred as the result of a severe crush or some sudden exertion on the part of a patient, whose heart muscle has degenerated. Such a rupture is generally found in the left ventricle near the septum, and the condition as a rule causes almost instantaneous death.

Wounds of the Heart. These injuries are usually due to stabs, gunshot, or impalement on spikes. Occasionally they are caused by crushes of the chest wall, in which sharp fragments of fractured ribs may be driven into the heart muscle. In most cases death occurs within a few moments, but an increasing number of successful cases of suture of the heart are reported (cardiorrhaphy), such cases always being due to external penetrating wounds (stabs and gunshot). The right ventricle is the chamber most often injured and the left auricle the least common, and such wounds sometimes implicate the muscular walls of the heart without penetrating its cavities. The thick muscular wall of a ventricle may suffice to check the hæmorrhage, and hence wounds of the ventricle have been found to be less dangerous than those of the auricle. The most favourable wounds are those produced by small objects such as stilettos, etc. In many cases the patient dies almost at once, either from sudden cessation of the heart's action, from intense external hæmorrhage, or from the pericardium becoming full of blood under pressure and this hindering the cardiac movements (*acute cardiac compression*). Occasionally the object which produced the wound may remain in situ and plug the aperture, thus preventing hæmorrhage; in such a case, of course, it must not be withdrawn except upon the operating table, when the heart is exposed and all preparations made to suture it. If the patient survives for a few hours he will be found usually with a small wound over the heart; collapse is intense, and he may have lost much blood. The pulse is small, irregular, weak and rapid; turbulent action of the heart, great pallor, restlessness, cardiac pain, air hunger and dyspnœa will be present. There may be an increase in the area of cardiac dulness, adventitious sounds on auscultation, especially whizzing, churning and bubbling sounds, and signs of a pericardial effusion. Should the patient survive for twenty-four hours or more, probably the signs and symptoms of a purulent pericarditis will supervene (see p. 460).

Treatment. Isolated cases of spontaneous recovery from a wound of the heart have been recorded, but they are very rare. If there is a reasonable certainty that the heart is injured, or the pericardium is full of blood, and provided the patient is not in extremis, an operation to open the pericardium and stop the hæmorrhage by suturing the wound in the heart will offer a fair chance of recovery. In any case, if the patient appears to be dying from "compression of the heart" by a pericardium full of blood, operation is urgently demanded to open the pericardium and relieve the pressure. If the pulse rate is rising and the general condition is getting worse, operation is a matter of grave urgency, but if the diagnosis is uncertain and the general condition improving, it may be justifiable to temporise by giving morphia and carefully watching the progress. In this case on no account must the wound be probed or disturbed unnecessarily. The operation is one of no special difficulty; local anæsthesia or gas or ether all can be used for its performance. The pericardium is exposed by turning up an osteoplastic flap comprising the skin and the fourth, fifth, and perhaps the sixth costal cartilages. This flap is best turned outwards to avoid injury to the breast. If necessary, a portion of the sternum may be removed, while if the patient is very bad, no attempt to raise an osteoplastic flap should be made, but two costal cartilages simply should be removed. The pericardium will be tense and dark from effused blood; it is quickly opened by a longitudinal incision and the blood let out, and sponged dry. The wound in the heart, when found, is temporarily closed by the fingers and the pulse probably will improve at once. Deep interrupted sutures are then introduced into the heart muscle to close the wound and tied, if possible during diastole. The pericardium is then sponged dry again, further stitches introduced into the heart if necessary to complete hæmostasis and the pericardium completely closed by suture without drainage. The flap of skin and muscle is sutured into place with a small drain down to, but not into, the pericardium for twenty-four hours. If healing occurs by first intention the prognosis is good, but should pericarditis supervene, death is almost inevitable. In some cases a foreign body should be looked for and removed if possible, while in others it will be found that the interior of the heart is not opened, and that the wound only penetrates a short way into the muscular wall, or involves one of the coronary vessels.

After the healing of a wound in the heart, the organ often remains dilated and fibrosis of the heart muscle and of the valves is by no means uncommon. The wound in the heart muscle heals by the formation of a fibrous scar, and as a result there are sure to be a certain number of adhesions between the heart and the overlying pericardium.

A few cases have recovered by means of organisation of a clot in the cardiac wound without operation, and in some of these instances sudden death has occurred ten or fourteen days afterwards from yielding of the weak scar owing to infection, or the patient exerting himself too soon.

Injuries of the Thoracic Duct. (See p. 397.)

DISEASES OF THE CHEST WALL

The skin, subcutaneous tissues and musculature of the chest wall are liable to the same diseases as in other parts of the body, and a full description of these conditions will be found elsewhere.

Boils and carbuncles are especially common on the back of the thorax, while *tuberculous and gummatous ulceration* of the skin over the ribs and sternum, and due to disease of the underlying bones, are frequently seen. *Lipoma and cold abscess* are both frequent on the chest wall, while the presence of any swelling in or under the skin in this situation at once raises the question as to whether it is connected with the underlying ribs or is protruding from within the thorax itself, as is the case if it is due to an *aneurysm, empyema necessitatis,* or *a hernia of the lung.* In the former case the swelling necessarily will be attached to the ribs underneath, while in the latter the presence of pulsation, impulse on coughing, reducibility on pressure or abnormal physical signs within the chest itself, usually will give the necessary information.

Pain in the side of the chest is a common symptom, and while it always suggests the presence of an inflammatory condition within the thorax, such as pneumonia, pleurisy or empyema (*q.v.*), it is often due to other less serious conditions. Severe pain in the side often will be present before an attack of herpes zoster (shingles), and it may persist in the form of an intractable **intercostal neuralgia** for some time after the eruption has passed off, especially in elderly people. Intense sharp catching pain in the chest during respiratory movements is strongly suggestive of pleurisy, but it must be remembered that it is frequently due to muscular rheumatism (myositis fibrositis) of the intercostal muscles. That this is the cause usually can be discovered in any particular case by the fact that there are tender spots over the muscles affected, that there is very little rise of temperature or constitutional disturbance, and there are no physical signs within the chest, while the previous history of the patient and his rapid improvement under anti-rheumatic treatment (antiphlogistine applied to the chest and salicylates by the mouth) will help in the diagnosis.

Gall-bladder pain and the pain of a duodenal ulcer are sometimes referred to the chest or right shoulder (see Chapters XV. and XVIII.).

Cellulitis is common on the chest wall, either under the skin or in the tissue planes under the pectoral muscles. In most instances it is due to spread of infection, either from the neck or from the axillary glands. It gives rise to a firm, brawny, tender swelling over the affected half of the chest, with much fever, redness and œdema. All movements are painful. Pus will form soon, and the swelling becomes boggy and fluctuates, while unless it is soon let out, the pus may track far and wide and give rise to a grave toxæmia. The treatment consists in early incision (see Vol. I., Ch. V.).

Acute abscess of the chest wall may follow wounds and injuries, infection of a hæmatoma or osteomyelitis of the clavicle, ribs or sternum.

Diseases of the Ribs and Sternum. Acute primary suppurative inflammation (acute osteitis) of these bones is uncommon, but it is occasionally seen as a sequel to acute osteitis in other bones (*q.v.*), or secondary to an empyema. Should it occur its signs and symptoms and course are the same as those of acute osteitis in other bones (see Vol. I., Ch. XVIII.).

Necrosis of a portion of a rib often follows an empyema operation and causes a persistent sinus.

A more common form of infection of a rib is that following typhoid fever (**typhoid osteoperiostitis**). Here the osteitis is of a subacute nature and causes more or less extensive caries of the bone, with the formation of a subacute abscess under the skin over it. There is little constitutional disturbance, and the condition usually arises towards the end of the attack of typhoid; occasionally it does not occur till years afterwards. The pathology is that of osteitis due to any other cause (see Vol. I., Ch. XVIII.).

Treatment. The typhoid bacillus is peculiarly liable to lie latent in these tissues, and so a mere opening of the abscess and scraping the bone is not usually sufficient. A complete subperiosteal resection of the affected portion of the rib is therefore the wisest course.

Syphilitic disease affects the sternum or sterno-clavicular joint much more commonly than the ribs and is not infrequent. In the sternum it takes the form of multiple gummata in the upper half of the bone, which erode the bone, form elastic swellings under the skin, and finally break on to the surface, forming characteristic gummatous ulcers. After ulceration has occurred, necrosis may set in. The condition must be distinguished from tuberculosis, new growths, especially sarcoma and secondary carcinoma, and protruding aneurysms.

In the ribs syphilis gives rise to a tertiary osteo-periostitis and produces a painless, slowly growing fusiform swelling, which may resemble closely a tuberculous caries. The history of the patient, the presence of other stigmata and the positive Wassermann reaction will help the diagnosis.

Treatment. The usual antisyphilitic treatment is required, but sequestra, if present, will have to be removed.

Tuberculous caries of a rib is common, but the disease is not often seen in the sternum. It is always secondary to tuberculosis elsewhere in the body, and is more common in middle life than in young people.

In the ribs it may start as a subacute osteitis, but often it appears to be more of a periostitis. It is not usually seen in children, and chiefly affects either the body of the rib or the costochondral junction. In rare cases it is due to a direct extension from disease in the pleura, the lung or the spine. It may cause expansion of the rib with or without caries, and ultimately in all cases it forms a cold abscess. The signs are those of a painless, slow-growing chronic inflammatory swelling along a rib, which gradually softens and breaks down to form a fluctuating swelling. If it is untreated the skin ultimately will get red and thin and give way to form sinuses. An X-ray film may show erosion or roughening of the bone. The abscess cavity often lies outside the rib, but frequently it is hour-glass shaped, part being inside and part outside the chest. In this case it will have an impulse on coughing, and will resemble a pointing empyema. In other cases the abscess may form behind the breast, which appears to float upon it, and then the pus will point ultimately below and outside the mamma itself (see p. 474).

Treatment. Mere opening and scraping the bone is not sufficient. Complete excision of the affected portion of the rib and the surrounding abscess cavity should be performed after turning up a flap of skin. The cavity can then be filled with iodoform emulsion, or ether, and the skin closed without drainage. Great care must be taken not to open the pleura.

In the sternum tuberculosis runs a similar course, the bone usually being involved near the angle of Ludvig, and the cold abscess may appear in front of the bone. Sometimes it forms behind the sternum in the anterior mediastinum, and then points through a neighbouring intercostal space. Here the treatment is similar, the abscess wall must be removed, and the diseased bone excised either by gouging or with bone forceps.

Cold abscesses are occasionally seen in the chest wall without any disease of bone, and in this case they are usually due to a tuberculous focus in the pleura or extrapleural space.

Actinomycosis of the sternum or ribs is occasionally seen secondary to disease in the lungs.

Tumours of the ribs and sternum are usually osteomata, chondromata or chondro-sarcomata, the latter especially occurring in the sternum. Osteoclastomata are also seen and may be multiple ; they are more frequent in the ribs. They are all very chronic and produce slowly growing, hard, nodular, irregular, painless swellings, quite unlike the elastic, chronic inflammatory swellings of syphilis and tuberculosis. The malignant ones in time become very big and may invade the pleura, lungs and diaphragm. They are comparatively painless and produce few physical signs, and for this reason care must be taken not to mistake them in their early stages for the prominence of the ribs produced by scoliosis and vice versa. Later cough from pleural invasion and referred pain along the intercostal nerves will develop.

Rarely a rapidly growing, pulsating sarcoma of the sternum is seen in middle-aged people which may resemble an aneurysm closely.

Secondary nodules of carcinoma, following cancer of the breast, are common in the ribs and sternum. Secondary sarcomata and hypernephromata are also met with in this situation and, unlike carcinoma, cause an obvious ovoid swelling ; diffuse cancerous osteomalacia of these bones is sometimes seen, but usually causes no bony enlargement.

Treatment. The small, non-malignant growths, if causing any discomfort, can be removed easily. The bigger and malignant ones also should be removed if their growth is slow and there are no physical signs pointing to severe involvement of the lungs underneath, in which case X-ray therapy should be resorted to. In most cases this procedure will entail making an extensive opening in the chest, and special anæsthetic arrangements therefore may be needed.

The pleural cavity should be opened a little distance away from the growth and a finger introduced ; if the growth involves the parietal pleura alone, its removal may be undertaken, but if the visceral pleura and lung are involved, it is best left alone.

The skin of the chest wall is a common site for a mole, keloid, fibroma, lipoma, nævus and lymphangioma. The latter may be mistaken for a cold abscess.

It is quite common to see patients with a prominence of one or more costal cartilages due to old rickets or scoliosis. In such cases little reliance can be placed on the history of how long the swelling has been present.

Erosion of the sternum and the anterior part of the upper ribs may occur in aneurism of the ascending aorta ; it is accompanied by intense pain, and ultimately a tumour develops which shows expansile pulsation.

DISEASES OF THE PLEURA AND LUNGS

Pleural Effusions. The surgery of the pleura deals very largely with the question of removing pleural effusions, which may be serous, sero-fibrinous, or suppurative. *Serous effusions* may be due to several causes. The common, clear pleural effusion is nearly always tuberculous, but similar clear effusions are not infrequently seen in connection with renal or cardiac disease, or due to pressure on the vessels in the roots of the lungs by growths or aneurysms. In the case of diffuse malignant disease of the lungs or pleura such an effusion is usually blood-stained. Pleural effusions in children show a considerable liability to become purulent, and this tendency is greater the younger the child is.

Treatment. There is considerable difference of opinion as to whether a tuberculous pleural effusion should be removed by aspiration or not; for such an effusion produces collapse of the lung, which may have a most beneficial effect on any tuberculous disease present in that organ. Unless, therefore, such an effusion is very large, and produces considerable displacement of the heart, dyspnœa, and dulness almost up to the clavicles, there should be no hurry about removing it by aspiration. Where, however, the effusion is definitely not tuberculous, removal of the fluid is strongly indicated. In many cases the chest will have to be aspirated with a hollow needle first for diagnostic purposes, and it will be found fairly often that the fluid withdrawn is purulent, although the physical signs did not suggest it. If aspiration is necessary it should be done at the spot where there is most dulness and loss of breath-sounds—the seventh intercostal space close to the angle of the scapula being in most cases a favourable situation to insert the needle. To prevent re-accumulation after aspiration a dram of adrenalin 1–1000 in 6 ounces of saline may be injected into the pleural cavity.

Empyema. An empyema, or collection of pus within the pleural cavity, may arise from several different causes, for organisms may reach the pleura in the following different ways:—

1. As an extension from inflammation in the lung, such as pneumonia, bronchiectasis or pulmonary abscess.
2. As a result of suppuration in or around the œsophagus, or in connection with one or other of the abdominal organs.
3. By the blood stream, in septicæmia or pyæmia, typhoid, influenza, or scarlet fever.
4. As a result of penetrating wounds (*q.v.*).
5. In many cases the infection is tuberculous and associated with a tuberculous lung underneath.

An empyema may be confined to a portion of the pleural cavity (*encysted empyema*), or it may involve the whole pleural sac (*total empyema*).

The organisms which may be the infecting agents in a case of empyema are many. In children the infection is more commonly due to the pneumococcus, and such cases usually arise in connection with pneumonia, bronchiectasis or pulmonary abscess. In adults the streptococcus is quite common; when this is so the infection very likely will be found to have spread through the diaphragm from an infective focus within the abdomen, either via the lymphatics or by direct spread, and in such a case the Bacillus coli often will be present also. Many empyemata are due to mixed infections, saprophytic bacteria sometimes predominating. The whole pleural cavity may be involved or the infection may be confined to the base, especially in cases where it has spread from the abdomen through the diaphragm. At other times a localised collection of pus will form between the lobes of one lung, and as such *interlobar empyemata* usually give rise to great difficulty in diagnosis, they exhibit a tendency to become chronic and persist for a long time. Occasionally collections localised at the apex are seen, and this condition is more common in children (*apical empyema*). In an early case the pleura is not very much altered in structure, although from the first it will be red and congested and there will be a certain amount of lymph deposited upon it. Cases produced by the pneumococcus appear to give rise to more lymph formation than do others, while if the pus has been present a long time and the case is chronic, the pleura, especially the parietal layer, will become enormously thickened and hard, owing to the formation of fibrous scar tissue, while it will be lined with a layer of granulation tissue. Such a thickened pleura is at times nearly an inch thick : it is as hard as cartilage and tends to draw the ribs close together. The lung collapses backwards towards the spine, and though at first its texture remains unaltered, after a time it becomes fibrosed and sclerosed, while pleural adhesions may form and divide the pleura up into compartments.

In an early case, after an effusion is removed, the lung expands readily, but in old-standing cases this is prevented, partly by the sclerosis of the lung tissue itself, and also by the way in which the visceral pleura has become thickened and hardened. Unless the lung expands after the effusion is removed, a large free space will be left in the pleura, lined by a pyogenic, granulating membrane, which will produce a more or less continuous discharge and which is certain to cause a persistent sinus, communicating with the exterior of the chest wall. The body is capable of making certain efforts to obliterate this cavity, and if the cavity is small it may be successful without the aid of the surgeon. The way in which this sometimes may be brought about is as follows :—

(*a*) The opposite lung will expand, becoming emphysematous and pushing the mediastinum over towards the diseased side.

(*b*) The ribs will fall in slightly and this will be helped by the spine undergoing a scoliosis with its concavity on the diseased side.

(*c*) The diaphragm will rise and play its part in obliterating the space.

(*d*) There will be an exuberant growth of granulations within the cavity.

Should these changes be insufficient to obliterate the space, the cavity will persist more or less indefinitely and may give rise to much discharge and ill-health.

If left untreated, an empyema sooner or later will burst through the chest wall and form a localised abscess under the skin. This usually occurs on the front of the chest, through the second or fifth intercostal spaces, but is sometimes seen in the axilla, where it resembles an axillary abscess ; when the pus is under the skin and outside the chest wall, it may track far and wide before finally bursting through the integument. This condition is known as an **empyema necessitatis**, and when it is situated on the left side of the chest the fluid may be felt to pulsate, owing to the transmitted pulsation of the heart (**pulsating empyema**). In other cases a neglected empyema may burst into a bronchus and the pus be coughed up. This is not a desirable state of affairs, as it carries with it a risk of drowning the patient, or of infecting the parenchymatous tissue of either lung by aspiration of the pus into other bronchi. Spontaneous cure has occasionally followed this accident, more especially in the case of interlobar empyemata.

The character of the pus varies to a certain extent with the nature of the organisms present. That due to the pneumococcus is usually thick and creamy, with abundance of fibrinous material in it. When due to streptococci, it may be thin and watery, while if the B. coli is present it may be brown or dark in colour and has a particularly offensive smell.

If left untreated, the patient will die ultimately from toxæmia, displacement of the heart or lungs, or general blood infection ; while in other instances pericarditis or peritonitis may supervene. An empyema does not often burst through into the abdomen, but cases have been recorded where the pus has tracked down the sheath of the psoas muscle and formed a psoas abscess, and also where it has presented in the back and loin.

Clinical Features. The signs and symptoms of an empyema may be overshadowed by those of the disease on which the condition supervenes, but they may be roughly stated as follows :—The heart will be displaced towards the sound side and the affected side will not move properly on respiration, while the intercostal spaces may be flattened or even bulging. On percussion there is marked dulness over the lower portion of the chest to a varying height, while at the apex of the lung and below the clavicle Scodaic resonance may be present, and in children there may be a box-like note. On auscultation the breath sounds are usually absent, though in children they may persist in a big empyema and even be tubular in character. Loss of vocal fremitus and marked ægophony are also important signs. Dyspnœa, rise of temperature and pulse rate, and leucocytosis are nearly always present, while there may be a swinging temperature with rigors, sweats and much pallor and toxæmia.

The diagnosis should always be confirmed by puncture with an exploring needle and syringe, for by no other means can the condition be distinguished with certainty from a serous effusion. The needle should be inserted near the top of a rib after drawing the skin up to produce a valvular opening, and in this way some of the pus may be withdrawn : the infecting organism should always be ascertained before operation, as it may influence greatly the nature and scope of the procedure to be undertaken and also the prognosis.

In those pneumococcal empyemata where large solid masses of fibrinous material are present the physical signs may be obscure, as the solid material conducts the breath sounds to the surface.

The prognosis in pneumococcal cases is good if they are small and unilateral. In streptococcal cases it is not so good, while those cases which follow scarlet fever, subphrenic abscess, influenza, pulmonary abscess, or septicæmia have a bad prognosis. A tuberculous empyema always carries a bad prognosis.

In obscure cases, and more especially in small localised empyemata, an X-ray picture will be of assistance and indicate where the pus is likely to be found.

Treatment. The later operation is undertaken the more will the lung be bound down and fibrosed and the thicker the pleura will be found to be. As a result the prognosis both as regards recovery and rapidity of healing will be best if operation is undertaken reasonably early. Aspiration has its uses occasionally as a method of treatment as well as a method of diagnosis, as early pneumococcal cases will clear up occasionally after one or more aspirations, especially in children. Moreover, in very large collections, in streptococcal cases, and where the patient is exceedingly ill, a preliminary aspiration sometimes will improve the patient's condition greatly, so that a more radical operation may be performed at some time afterwards with a smaller degree of risk. Bilateral empyema is not common and is usually seen in children. When it is encountered it is wisest to perform an aspiration on one side (the smaller side), while the bigger collection may be operated upon in the ordinary way, but here in some instances it may be thought wiser to aspirate both sides as a preliminary.

In general, it must be remembered that there are two important points in the consideration of the treatment of an empyema :—

1. The nature of the operation performed may depend upon the organism present and how long the empyema has been there.

2. It is not sufficient to apply a routine treatment to all cases, consisting in removing a portion of a rib and inserting a tube. This is an old-fashioned procedure and is followed by a large number of persistent sinuses.

(A) Empyemata are occasionally divided into the two classes of *synpneumonic* and *metapneumonic*. The former class, occurring simultaneously with pneumonic changes in the lung, and therefore really being part of a general blood stream infection, are far the more serious, and include the streptococcal cases. The whole pleural cavity is often involved, no adhesions being present and no attempt at localisation.

(B) The latter class represent the ordinary empyema following pneumonia. In this class adhesions are often present or well formed after a few days and then the empyema becomes localised to part of the pleural cavity. Thus the whole process is less acute and more localised than in class A. In this second class therefore early open drainage may be wise, but in the former class it must be delayed for some time and probably be avoided altogether.

(A) In those empyemata due to the streptococcus (usually following influenza or septicæmia) the results of treatment by repeated aspiration are far better than those of early drainage. The pus in these cases is usually thin and watery, and aspiration may be persisted in until it becomes thicker and more creamy. When this occurs drainage by operation may be performed, and it should usually take the form of a closed or suction drainage. If repeated aspiration fails to cure the condition (as it often does), then one or other forms of closed suction or syphon drainage must be employed for a time : this may have to be followed after a week or two by open drainage. Open drainage should never be undertaken early in a streptococcal empyema as it does more harm than good.

(B) We should have three objects before us in performing an operation on a pneumococcal empyema of the second class, namely, to let out the pus, to ascertain the state of the pleural cavity, and to remove the large amount of slough and the big fibrinous masses which are so often found to be present. The ideal operation, therefore, which usually can be performed in most adults who are moderately fit, consists in resecting a large portion of a rib, opening the pleura, separating the ribs so that the hand can be introduced, letting out all pus, inspecting the pleural cavity thoroughly and removing all solid fibrinous masses. In most cases this will have to be followed by drainage of the pleural cavity. It must, however, be realised that the pleura, like other serous membranes, has a considerable power of resisting infection when properly treated, and in early cases due to the pneumococcus it will be found that if primary suture without drainage is performed and the air replaced by oxygen, after the pleural cavity has been thoroughly cleared out, in about 15 per cent. of cases primary healing by first intention will be obtained. Should the temperature rise again and signs appear of a reaccumulation of fluid, one or two aspirations may be sufficient to clear it up, but in many cases the wound will need reopening and draining, which is easily done. In cases where the pus has been present more than four or five days, or in all cases where the infecting organism is other than a pneumococcus, the operation must be completed by draining the pleural cavity with a large but short tube, and this tube must not be long enough to press upon the lung or diaphragm. The portion of rib to be resected should be as far back and as low down as possible, care being taken to avoid the scapula, while the best skin incision will be found in most cases to be a vertical one. With this incision enlargement downwards is easy, and there is no chance of the openings in the skin and in the rib not corresponding in position. The seventh or eighth rib is usually selected for excision, and the periosteum is first exposed, incised longitudinally and then stripped off the front, sides and back of the rib with Farabœuf's rugine and Doyen's curved rib elevator. In this way there is no danger of injuring the intercostal arteries and nerves. At least 3 or 4 inches of the rib are excised with forceps, the periosteum at the back of the rib and the parietal pleura incised and the pleural cavity opened. The drainage should continue for as short a period as possible, but usually it will be found necessary to leave the tube in situ until the discharge becomes thin and serous, which may take anything from about three days to a fortnight. As soon as the tube is removed every effort should be made to encourage the lung to expand, and this is best accomplished by applying Klapp's suction bell and making the patient take gentle, deep breathing exercises, play wind instruments, swing dumb-bells, and blow water from one Wolfe's bottle to another through a tube.

Although irrigation of the pleura may be useful in chronic empyema sinuses, we do not advocate it in acute or recent cases.

There are three instances in which this somewhat extensive operation described on p. 445 may not be wise :—

1. In the case of patients who are desperately ill, usually with very large, neglected empyemata. Here resection of a rib might be too severe an undertaking, and as an emergency proceeding either aspiration or the insertion of a large trocar and cannula or drainage by an incision between two ribs probably will be more successful.

2. In the case of children. In infants and small children the results of the ordinary operation of rib resection for empyema are bad. Everything must be done to diminish the magnitude and shock of the operation, and it is therefore better not to remove a portion of the rib, but to be content with making a small opening between two ribs and introducing a tube. This can be done either by means of an incision, or else with a trocar and cannula, and the procedure should be supplemented by means of syphon or suction drainage through the tube (closed drainage). Children do not tolerate open drainage of the pleural cavity well, and syphon or suction drainage has therefore considerable advantages in their case.

3. In the synpneumonic and streptococcal cases as described on pp. 444 and 445.

The question of the most suitable anæsthetic for such an operation is important. Though the operation for empyema can be performed under local or regional anæsthesia, a general anæsthetic in the form of gas and oxygen, evipan, or ether is quite satisfactory. There is no need for intratracheal ether, while local anæsthesia is best reserved for patients who are very feeble. It has often been stated that the patient should never be laid upon his sound side for the operation to be performed, but should lie either upon his back or upon the side of the empyema. We have never found any objection whatever to placing the patient upon his sound side for the operation to be done, provided he is properly packed up with sandbags to allow the chest to expand.

The *treatment* of the localised forms of empyemata, namely the apical, interlobar, basal and diaphragmatic types, is similar, but great care must be taken to make the incision directly over the collection of pus and not to break down the adhesions and infect the rest of the pleural space, and in these cases open drainage is undoubtedly best. Irrigation of the chest with antiseptic solutions is unnecessary and in the first few days has proved dangerous, giving rise to collapse and even sudden death from pleural shock; in chronic empyema sinuses it is safer and more beneficial (*q.v.*). Great care must be taken that the drainage tube is securely fixed, as many such tubes have disappeared into the pleural cavity, and extraction of them may be difficult.

Tuberculous Empyema. This may appear insidiously in a case of phthisis, and result from the infection of a pre-existing serous effusion. In other instances it occurs more or less suddenly from the rupture of a phthisical lung cavity into the pleura, usually with escape of air into the pleural cavity too (*tuberculous pyopneumothorax*). In the former case the pus may be sterile or may contain a pure culture of tubercle bacilli, but in the latter it will contain usually other organisms, such as streptococci and staphylococci, as well. Both conditions are serious events, and treatment is unsatisfactory, for aspiration is likely to be followed by tuberculous infection of the needle track, and drainage is certain to be followed by a sinus, for the lung is diseased and adherent and will not expand; while if there is a patent opening into a bronchus, a pleuro-bronchial cutaneous fistula may form. Operation should be avoided, therefore, for as long as possible, but if it becomes necessary owing to severe displacement of the heart or intense toxæmia, it is best to combine drainage with removal of some of the overlying ribs to enable the pleural cavity to fall in and perform an operation rather similar to that required for chronic empyema sinus or to the thoracoplasty performed for phthisis (see p. 455).

Chronic Empyema Sinus. In far too many cases, in spite of efficient drainage of an empyema and respiratory exercises, the sinus communicating with the pleural cavity refuses to heal. It must be remembered that if the collection of pus has been a large one a sinus may not close for several weeks, and yet gradually cease discharging at the end of that period, but if such a sinus is not healed at the end of three months it is not likely that it is going to heal spontaneously, and the question of further surgical treatment to close it will arise.

The causes which may prevent such a sinus from healing are various: in many instances the primary operation has been inefficiently performed, in that it has either been delayed too long or else because no attempt has been made to remove the sloughs and fibrinous masses (which act as foreign bodies) from the pleura. Other cases are due to fibrosis and sclerosis of the lung parenchyma, thickening of the visceral pleura or pleural adhesions; while it is by no means uncommon to find lying in the unobliterated pleural cavity one or more pieces of drainage tubing, and even safety pins and gauze plugs which have been "lost." Caries or necrosis of the rib at the point where it was sectioned is also seen, and this too will prevent the sinus from closing, while in other instances the supervention of a tuberculous infection of the pleura will account for the condition. In these cases the pyogenic granulating membrane lining the pleural cavity continues to form pus, and should the sinus for some reason become temporarily occluded, a re-accumulation of pus will occur in the pleural cavity and give rise to fever and further signs of a pleural effusion; in any case a long-standing empyema sinus will cause considerable ill-health, anæmia, cough and dyspnœa, while in some instances it will lead to clubbing of the fingers and lardaceous diseases. Unless the condition is cured by operation the ultimate prognosis is grave.

An X-ray photograph of the chest should always be taken, as this will show the extent of the cavity, the condition of the underlying lung and pleura, and, in many instances, the presence of such causes as a foreign body in the pleura or necrosis of a rib.

Treatment. In a few instances, where the cavity is small and no such cause as necrosis or a foreign body is present, an autogenous vaccine or irrigation with mild antiseptic solutions, such as eusol or carbolic, may cause it to close, but in most instances operation will be the only remedy, and this should be undertaken if the sinus persists for more than three months, provided the condition is not tuberculous. The exact size of the cavity may be ascertained by means of an X-ray photograph taken after the sinus has been filled up with lipiodol or bismuth solution, and also by percussion, and still better by the use of the thoracoscope. If the cavity is at the base of the lung benefit will be obtained by a phrenic avulsion.

At first the cavity should be opened up and an airtight tube introduced to which suction can be applied. This will often diminish the size of the cavity. If this fails a bigger operation must be undertaken to obliterate the cavity either by allowing the rigid chest wall to fall in to meet the lung or to encourage the lung to expand to meet the chest wall, or by a combination of these two proceedings.

The procedures for allowing the rigid chest wall to fall in are two in number:—

(1) **Estlander's Operation.** This consists in the removal of portions of the ribs overlying the cavity, either by one vertical incision or multiple horizontal incisions. Though it may suffice to obliterate a small cavity, it is not likely to succeed in the case of a large one, as the thickened and tough parietal pleura may prevent the chest wall from falling in almost as effectively as do the ribs.

(2) **Schede's Operation.** This is a considerably more severe procedure than Estlander's operation, but it is likely to prove more effective in the case of large cavities. In this operation not only are the ribs removed, but also their periosteum, the intercostal muscles and the thickened parietal pleura, nothing being left of the chest wall to cover the lung except the skin and subcutaneous muscles. The operation is performed by turning up a flap of skin and subcutaneous tissues, the apical part of which will correspond with the lowest part of the cavity. This flap should not be turned up all at once, but, commencing at the bottom, it is enlarged step by step as the cavity is exposed. The lowest rib covering the cavity is first removed, and then the whole of the cavity is completely exposed by removing all the other ribs, which comprise its outer wall, together with the pleura and intercostal muscles. The outer wall of the cavity may be resected entire, removing ribs, intercostal muscles and the pleura in one piece from below upwards with sharp bone forceps. The periosteum must be removed to prevent the formation of new bone. The intercostal vessels are tied, the pleural cavity cleaned out with antiseptics, and the skin flap sutured back into place and pushed down on to the lung by means of bulky dressings. Drainage must be provided for a few days. This method of performing the operation from below upwards ensures that the right amount of the outer wall of the cavity is removed, for it is impossible to say how much will need removal until the cavity itself is thoroughly exposed. It is a severe operation, and will be followed by considerable shock; when this has passed off there will be considerable reaction and the patient probably will run a high temperature for several days, but this will settle down gradually, and in a successful case the sinus should close in about four weeks. The chest wall will be left weak at this spot and a considerable amount of compensatory scoliosis of the spine will occur.

Wilms' operation (see p. 453) has also been performed to obliterate these cavities. It gives rise to less after-deformity and weakness, but its chances of obliterating a large cavity satisfactorily are very much less.

The other method of attempting the closure of such empyema cavities by causing the collapsed lung to re-expand is known as **decortication of the lung.** Here the pleural cavity is freely opened by removal of one or more ribs, and an incision is made down the whole length of that part of the visceral pleura which forms the bottom of the cavity. When this has been done, in most cases the thickened visceral pleura can be dissected off the underlying lung quite freely, though care must be taken not to tear the lung tissue. After this has been completed, if the anæsthetic is being given by the intratracheal method and the anæsthetist is asked to raise the pressure considerably, in many cases the lung will be seen to expand immediately. If, however, the lung tissue is sclerosed and fibrosed, we cannot hope that this will occur. In other cases it is of advantage to combine a decortication of the lung with a partial Estlander's operation or Schede's operation. It will occasionally be found that the visceral pleura cannot be stripped off the lung, and if this is the case, and it is still thought that the lung is capable of expansion, the visceral pleura may be criss-crossed by incisions in various directions, going down to, but not into, the lung substance (**discission of the pleura**), and this may enable the lung to expand to a certain extent.

New Growths of the Pleura. These are rare, but are usually endotheliomata rather similar to those seen in the dura mater, and in many cases they are not malignant. They give rise to no symptoms at first, but on examination there is an area of dulness corresponding to the growth, and signs of compressed lung tissue underneath. They are best diagnosed by the thoracoscope and, when small, should be removed by opening the pleura and excising the affected portion, together with the ribs over it if necessary.

Hydatid Cysts. These occasionally occur in the *pleura.* Their diagnosis and treatment are similar to when they occur in the lung.

DISEASES OF THE LUNGS

The diagnosis of diseases of the lungs is always difficult, and it should be remembered that the evidence of the stethoscope alone usually indicates a lesion above the root of the lung, too high, and a lesion below the lung root, too low. Fortunately, an X-ray film usually will give exact information on this point.

It is only certain diseases to which the lungs are liable which are at present regarded as suitable for surgical treatment, but a considerable increase in the scope of surgery in this region of the body is occurring as new methods are introduced.

Abscess of the Lung. Abscess of the lung is not an uncommon condition and may be acute or chronic. It is three times as common in males as in females and more common on the right side than the left. It may follow an acute infection of the lung tissue, such as a septic pneumonia, or be due to the spread of infection around a bronchiectatic cavity. In other cases it is the result of an infarct of the lung, and in very many instances it supervenes as a sequel of the lodgment of a foreign body in a bronchus ; cases will be seen in which this has occurred after operations in the regions of the mouth, nose and throat, especially tonsillectomy and dental extractions, when it usually commences in about ten or fourteen days. Should a foreign body of any kind lodge in a bronchus, if it is not removed, an abscess of the lung is exceedingly likely to occur. Other causes of the condition are a suppurating hydatid cyst, and also a general pyæmic or septicæmic infection, or any condition which occludes a large bronchus such as an aneurysm, growth or mass of glands. In these latter cases the abscesses are usually multiple, and they will not then be suitable for surgical treatment.

An acute abscess has practically no capsule or barrier round it, but the chronic abscess has a very thick, hard, fibrous capsule. The acute abscess gradually passes into the chronic type if the patient survives long enough.

The signs and symptoms of a pulmonary abscess in its early stages may be obscure, but as the condition advances they will become very definite and characteristic. The diagnosis of such an abscess is made by noting that after an attack of pneumonia or the inhaling of a foreign body the signs of a persistent localised consolidation or of a cavity in the lung will be present, with an offensive purulent sputum and a swinging temperature. The amount of expectoration bears no relation to the size of the abscess cavity. The patient becomes very ill, with pallor, sweats and wasting, and rapidly goes downhill. In the sputum, which is profuse and foul, fragments of lung tissue or elastic tissue and hæmatoidin crystals may be found, while an X-ray examination may show the presence of the abscess and its situation. After a few days such an abscess may burst into the bronchus, and in some cases, especially if the abscess is in the upper lobe, this may lead to a spontaneous cure, but if the general signs are not relieved, or if the purulent sputum continues for more than a few weeks, operation will have to be undertaken.

Treatment. An acute abscess should be treated by medical measures. assisted by positional drainage and perhaps when not too acute by bronchoscopy.

In the case of a chronic abscess, however, surgery will probably be necessary, though some authorities treat these chronic abscesses also by bronchoscopy or by artificial pneumothorax to collapse the abscess cavity. An artificial pneumothorax is only safe in the case of a chronic and deep-seated abscess with a good thick capsule and then it often fails. If it is too near the surface of the lung a pyopneumothorax may result. A phrenic avulsion will at times assist an artificial pneumothorax. Bronchoscopy, which has to be repeated many times, often makes the patient feel better, lowers the temperature and diminishes the sputum, but it probably never produces a cure. It is however of value as a preparation for operation.

We feel, however, that, as in the case with abscesses in other situations, the correct treatment of this condition consists in incision and drainage. Here we are dealing with a patient who generally has a profuse, purulent expectoration, and ordinary methods of anæsthesia are, therefore, open to the risk that the patient may be drowned or develop a septic pneumonia owing to the pus pouring or being aspirated into the opposite lung or other parts of the same lung. This is, therefore, one of the chest conditions where intratracheal ether is the best anæsthetic, for it keeps the airway clear, prevents inhalation, and tends to force the pus out of the operation wound as soon as the abscess is opened. Local or spinal anæsthesia also is valuable. The abscess can be localised approximately by X-rays. A step which always should be taken is the insertion of a needle for exact localisation of the abscess (and in some cases to settle the diagnosis), but this should be done after the patient is anæsthetised and on the table ready for the operation to proceed; when the pus has been found, the needle may be left in place as a guide. Unless there are other indications from the X-ray film or other sources, it is best to commence by inserting the needle at the point of maximum dulness. When the pus is found (as shown either by its appearance in the syringe or by the odour), or if it cannot be struck by the needle, a vertical incision is made through the skin and a large portion of one or two ribs which appear to be nearest to the abscess (as shown by the needle or the physical signs) is removed. The pleura is then palpated gently, and it will be found that one of three conditions is present: either—

1. The parietal and visceral pleuræ will be adherent at that spot, and the abscess be immediately underneath.
2. The two pleural layers are not adherent at that spot, but they are adherent at some other spot close by.
3. The two pleural layers are not adherent anywhere.

These are points of great importance, for so vital is it to avoid infecting the pleural cavity that no attempt to open into the lung abscess must be made unless the two pleural layers are already adherent, or are first sutured together at the point selected.

In case 1, though adherent, it is wise to enforce the adhesions by stitching the two pleural layers together with a ring of sutures before incising the lung.

In case 2, any opening made into the free pleural cavity must be closed and a fresh opening made at the spot where the pleura is adherent after reinforcing sutures have been introduced.

In case 3, the lung must be palpated to ascertain where the abscess is, and that portion of it which appears to be nearest to the abscess must be drawn up and sutured to the parietal pleura before it is incised. If this is impossible, the wound should be packed with gauze to promote the formation of adhesions, and the abscess opened six or eight days later.

Some surgeons recommend that the operation should be performed always in two stages, the first stage consisting in exposing the pleura but not opening it. The freely exposed pleura is then firmly pressed down upon the visceral pleura with a big gauze plug soaked in iodine, the wound is resutured and the plugging is then left in it for about five days. The iodine preserves asepsis, irritates the pleura and makes the two layers adherent. In five days or so the operation is completed by reopening the wound, taking the pack out, and opening the abscess through the adherent area.

When one or other of these steps has been done, the visceral pleura is incised, the lung tissue incised with a diathermy cautery and the abscess opened. Pus is let out, gangrenous lung tissue is gently removed with the finger or a scoop, and the cavity explored. Drainage of the cavity must then be established. This is best done by a large tube, which is passed into the cavity and surrounded by lightly packed gauze plugging to control any hæmorrhage. An abscess usually will give an indication of its position by the increased hardness or resistance of the lung tissue within its neighbourhood, but if on exploration no pus or abscess cavity can be found, the tube should be passed down into the hard and indurated area in the hope that pus may come out through it in a short time. In a few days, after the discharge has ceased to be offensive, the tube may be gradually reduced in length. Irrigation of a pulmonary abscess cavity is not recommended, for such a cavity frequently communicates with the bronchus, but suction is valuable at the time of operation. Those cases of lung abscess which recover after operation show considerably less tendency to form a sinus than do ordinary cases of empyema; nevertheless the same measures should be taken to promote expansion of the lung after operation as in an ordinary empyema, to eliminate the suppurating cavity in the lung tissue as soon as possible.

Prognosis. The prognosis of such a case is reasonably good, about 60 per cent. of recoveries being expected in cases treated by operation. Under medical treatment alone only 15 per cent. of cases recover.

Gangrene of the Lung. The causes of this condition are, in general, the same as those of pulmonary abscess. It is occasionally found to follow cases of ordinary lobar pneumonia in debilitated subjects. Pathologically the process is almost exactly similar to the formation of an abscess in the lung, the difference in this case being that the infection is more virulent and the patient's resistance less efficient, so that the infective process spreads and causes death of large portions of lung tissue, while the tissues do not react with the formation of a wall of fibrous tissue to limit the spread of the disease. The physical signs and symptoms are much the same, the signs of consolidation or cavitation being present, usually at the base of the lung, while the general condition of the patient is very much worse. The temperature may be high and swinging, but is frequently subnormal, and the patient profoundly toxic. The sputum is copious, dark-coloured and exceedingly foul; it separates on standing into an upper frothy layer, a middle dark-coloured fluid layer, and a bottom layer of greenish-brown semi-solid tissue in which disintegrated lung parenchyma will be found. Occasionally severe hæmoptysis will occur. The treatment is similar to that of a pulmonary abscess, but the gangrenous portion of lung must be removed freely. The prognosis is very much worse.

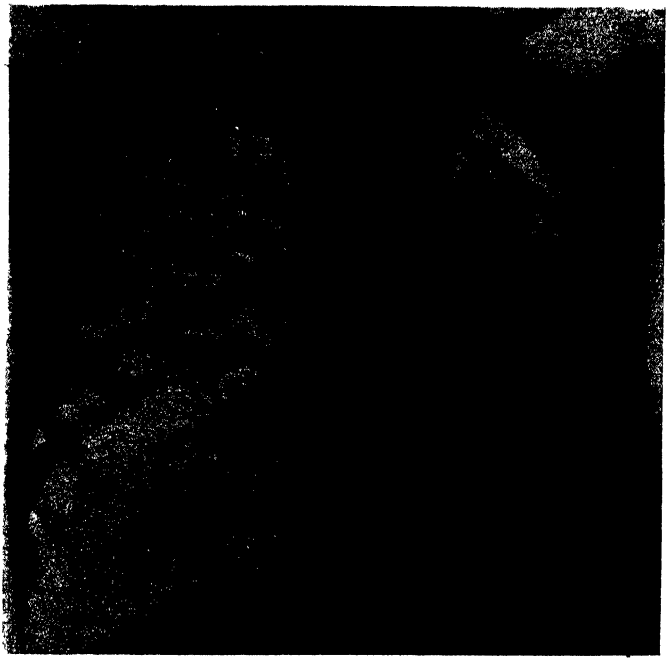
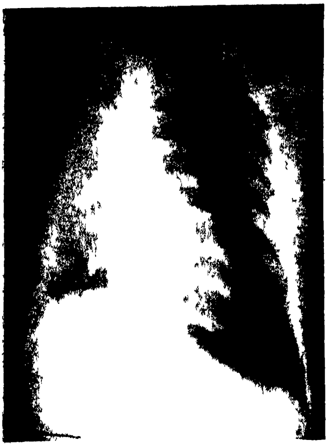


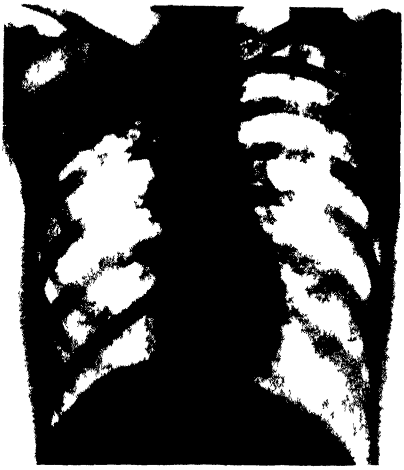
FIG. 154. X-ray film showing how the bronchial tree can be demonstrated by the injection of lipiodol into the trachea. In this picture the left side is in a very advanced stage of bronchiectasis, whilst the right side is normal.

Bronchiectasis. In this condition, as a result of previous fibrosis of the lung, there is a dilatation of the bronchial tubes, with the formation of large spaces in the lung in which secretions accumulate and decompose. There are many causes of this condition, which are much the same as those of pulmonary abscess. The condition is a very chronic one, and gives rise to considerable

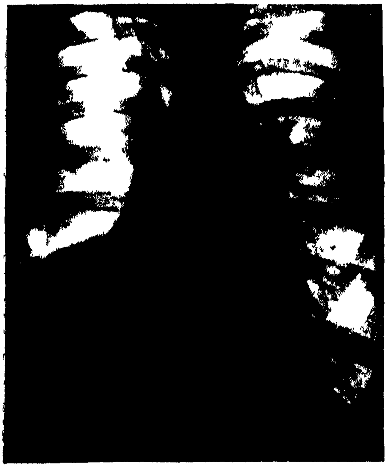
PLATE II.



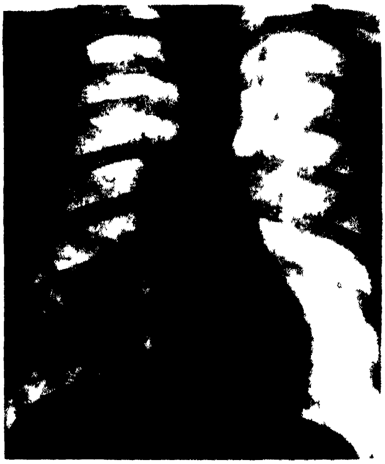
A Complete thoracoplasty



B. Upper thoracoplasty



C. Results of phrenic section



D Carcinoma of the lung

general ill-health, together with a profuse and very foul sputum. Clubbing of the fingers and gradual shrinkage of the lung occur, giving rise to displacement of the mediastinum, while the diagnosis and extent of the disease can be confirmed by X-ray films. The patients become very toxic and short of breath, while hæmoptysis may be frequent and severe. The cough is so incessant and the sputum so foul that they are intolerable to themselves and to other people. The condition may be confined to part of one lung, but, unfortunately for surgical treatment, usually it is diffusely spread throughout one or both lungs. In common with other chronic septic conditions in the chest, abscess in the brain is a frequent terminal complication.

Treatment. The treatment of this condition is in the first instance medical, and surgery can hope to benefit only those cases where the disease is confined to one lung, or even part of a lung. The opening and draining of bronchiectatic cavities is not satisfactory, as they are usually multiple, and the only procedures which are likely to prove beneficial are those which aim at obliterating completely the diseased portion of the lung or removing it radically. The condition of the bronchi and the extent and distribution of the bronchiectatic condition can be investigated by means of an X-ray photograph after lipiodol has been injected (see Fig. 154). About 4 c.c. of lipiodol are injected into the larynx with a special syringe and needle through the cricothyroid membrane; the fluid can be directed into whichever side is required by placing the patient upon that side. There is no discomfort or coughing, and no anæsthetic is required. Excellent pictures thus may be obtained. Equally good results can be obtained by instilling the lipiodol into the larynx through the mouth by means of a special syringe.

Wilms' operation, which consists in removing small portions of the anterior ends of the upper nine ribs and, at a later date, excising similar small portions of the posterior ends of the same nine or ten ribs in order to allow the whole side of the chest wall to fall in *en masse*, has proved beneficial in some cases, but the collapse is not as a rule sufficient. Phrenic avulsion or a thoracoplasty performed on the same lines as that performed for phthisis (see p. 455) has also given a considerable measure of success, though owing to the rigidity of the dilated bronchial tubes neither of these procedures is as successful as they are in phthisis; other operations which have been undertaken have consisted in ligature of the branch of the pulmonary artery going to such a lobe, while the diseased portion of the lung has been burnt out by repeated applications of a powerful cautery. Another operative treatment consists in bringing the affected portion of the lung out of the chest through the incision, and fixing it tightly there: in a few days it sloughs away. This can be done only in those cases where the disease is localised and the lung free from adhesions. These last three operations gave somewhat disappointing results, and as they are by no means free from risk they are seldom practised in this country now.

An artificial pneumothorax is not usually beneficial, as the dilated bronchi are too stiff and rigid to be collapsed by this means.

Though not very satisfactory, these "collapse methods" such as thoracoplasty and phrenic avulsion are the best procedures when the disease is more or less diffusely spread over the whole lung, as is unfortunately very common; but if the condition is localised to one lobe or even two lobes, or even the lower lobes of both lungs, by far the best treatment is to remove the diseased lobe by the operation of **lobectomy.**

An artificial pneumothorax is done first and the chest is opened between two ribs by a long incision. No bone need be removed, but the procedure is sometimes made easier if the ribs immediately above and below the incision are cut across. The affected lobe which is usually adherent is set free and the dissection gradually carried down to the root or hilum of the lung. As soon as this is exposed, two special clamps are applied to the root of the lung. Some surgeons prefer to use special instruments known as snares, though they are really tourniquets. Between these two clamps the hilum is cut across and the lobe removed. The stump of the hilum, gripped in the deeper clamp, is then dealt with, the vessels tied or sutured and the bronchus closed and sealed over. This may be done by crushing the bronchus, and as the risk of the ligature coming off is always present, it is wise to sew the hilum over with mattress sutures. The clamp is then removed and the stump sewn over with pleura or a portion of lung tissue. An alternative method of doing this is described on p. 458. As pleural infection in a mild form is almost certain to follow, most surgeons leave a small tube in, usually through a separate stab incision; others wait and see and probably have to put a tube in later if aspiration fails. The results of this operation are good; the remaining lung tissue rapidly expands and fills the chest, and the mortality is in the neighbourhood of 10 to 15 per cent.

The risks of a lobectomy depend very largely on whether the patient is very toxic or not. In early cases with little or no toxæmia the risk is not more than 7 per cent., but in advanced cases, with pallor, cyanosis, breathlessness, etc., the risk is far greater, being in the neighbourhood of 40 per cent. Moreover, generally speaking, the more toxic the patient is, the more adherent and rigid is the lobe, this making the operation much more difficult and severe. Children stand lobectomy very well, often better than a laparotomy.

In a few cases where the disease has existed in both right and left lower lobes, a lower lobe lobectomy has been done on both sides—with a good interval between them. In other instances where the disease has extended over the whole of one lung, removal of the whole lung has been successfully performed (*total pneumectomy*). Special preparations in the form of "cavity-emptying" by posture, bronchoscopy and suction, must be carefully carried out and special forms of anæsthesia are necessary. High spinal anæsthesia is very suitable, while failing this gas and oxygen after premediation, or very light chloroform anæsthesia (if the patient is not very toxic), are also suitable.

Phthisis. Surgery is beginning to play an important part in the treatment of cases of phthisis. The artificial pneumothorax treatment of this condition, by which a partial or total collapse of one lung may be obtained in order to put that organ completely at rest, is definitely established as a procedure conferring great benefit upon suitable cases. For this treatment to offer a possibility of improvement it is essential that the disease should be more or less confined to one lung, or at any rate much more advanced on one side than the other. Tuberculosis probably is never confined absolutely to the one lung, but if there is only a mild degree of infection on one side, and a severe degree on the other, the case may be regarded as suitable for artificial pneumothorax. For the way in which the details of this treatment are done the reader is referred to special works on the subject.

In certain cases artificial pneumothorax is impossible, owing to the two layers of pleura being adherent to each other, so that the lung cannot collapse. These pleural adhesions are of two kinds, consisting in some cases of a few isolated, thick, cord-like bands, while in other cases the two pleural surfaces are densely adherent to each other over large areas. In the first case, where there are a few cord-like adhesions, an incomplete artificial pneumothorax may be achieved, and then it is quite easy to sever the restraining adhesions by cutting them with a small knife, the actual cautery or the diathermy knife, without an open operation, with the aid of the thoracoscope (intra-

pleural pneumolysis). The section must be made as near the parietal pleura as possible. This is a better and safer procedure than opening the pleura and cutting the adhesions. In performing a *thoracoscopy* a certain degree (as complete as possible) of artificial pneumothorax is first established, and the thoracoscope is then introduced into the pleura by puncture with a trocar and cannula. The lung, pleura and pleural adhesions can be seen and examined freely, and in order to cauterise the adhesions a special long cautery is introduced into the pleural cavity by means of a second puncture, and is guided by direct vision with the thoracoscope while the adhesions are being cut. To avoid making a second puncture the ordinary defulgurising cystoscope may be used, or a thoracoscope with a diathermy electrode passed down it. The whole procedure is done under a local anæsthetic. When these adhesions have been severed the lung may be collapsed completely by producing an artificial pneumothorax in the ordinary way.

In the other type of case, where the two pleural layers are extensively and closely adherent, the thoracoscope cannot be used, as there is no free space to insert it into, and these are the cases in which operative procedures are valuable. Before undertaking any elaborate operation to collapse the lung, the opposite lung must be meticulously examined, and if there is anything more than the slightest amount of infection in it, the operation had better not be undertaken. The type of disease which is most likely to be benefited by operative treatment is the chronic type with extensive cavitation, fibrosis, profuse expectoration, and occasional hæmorrhages. Several operative procedures may be employed in such a case.

One operation, known as **Extrapleural Pneumolysis**, consists in making an opening between two ribs down to, but not through, the pleura; the ribs are then forced apart by means of a rib-spreader, the hand is inserted outside the pleura, and the parietal pleura gently stripped off the ribs with which it is in contact. This may be done all over the apex of the lung, and down the back and sides as far as necessary. The lung then collapses, and the large extrapleural intrathoracic cavity left must be filled with some sterile substance to keep the lung collapsed. Fat, muscle and sterile paraffin wax have been used for this, and the ribs are then drawn together and the wound closed without drainage. The operation produces a most satisfactory collapse of the lung, with no deformity whatever, but, unfortunately, it is often found that the foreign substance introduced to fill the cavity gives rise to trouble weeks or months later, and it may be extruded or have to be removed.

Some surgeons perform this operation from the back of the chest, but it is best performed from the front between the second and third ribs.

A more recent method consists in an extrapleural freeing of the lung as here described. If there is any free pleural cavity this will probably be opened into and thrown into the space with the extrapleural space already made. When this has been extensively done the wound is resutured in at least two layers and air is introduced with an artificial pneumothorax apparatus, an **extrapleural pneumothorax** being thus produced. Frequent refills are necessary. This method has at present largely replaced the use of paraffin wax, etc., but it must be remembered that the surgery of phthisis changes from week to week probably only to vanish altogether in the very near future.

Another procedure, though more severe, in many cases gives better results. This consists in a **thoracoplasty** performed on the lines of Saugman's operation, in which a J-shaped incision is made down the back parallel to and about 3 inches from the spinous processes, starting opposite the seventh cervical vertebra and turning forwards towards the side of the chest, about 3 or 4 inches below the angle of the scapula. The muscles are separated, the ribs stripped of their periosteum, and as large portions as possible of the upper nine or ten ribs removed. The first rib must be included, and the portions should be removed right back to the angle of the rib and as far forward as possible. Altogether about 35 to 45 inches of rib are removed. In this way an extensive collapse of the side of the chest wall is brought about without opening the pleura. The wound is closed, but a drainage tube is inserted for forty-eight hours; when healed, the patient should wear a supporting apparatus to prevent the chest bulging when he coughs, while it is often wise to perform the operation in two stages with an interval of two or three weeks between. The operation is best done under avertin and gas and oxygen anæsthesia; light chloroform may be used, but ether is undoubtedly harmful to phthisical lungs. The intercostal nerves are infiltrated with alcohol before they are exposed in order to prevent shock and, still more, diminish severe after-pain. We do not regard local anæsthesia as suitable for the operation, though it is popular on the Continent.

This complete thoracoplasty is now performed much less often, as its place is being taken to a considerable degree by a localised apical thoracoplasty. This is naturally more suitable for localised apical disease. A similar but higher and smaller incision is made, and extensive lengths of the first three to five ribs are removed from the back. Almost the whole of the first rib should be taken away. This may be combined with an extensive stripping of the pleura all round the apex, off the ribs and surrounding tissues, and by these means a very complete and permanent collapse of the apex may be obtained. There is less shock than after the complete operation and practically no visible deformity.

In order further to immobilise and collapse the base of the lung, these operations well may be combined with **avulsion of the phrenic nerve** in the neck, this paralysing the diaphragm and allowing it to ascend. This operation is performed as follows: a transverse incision two inches long is made just above the clavicle and outside the sternomastoid. The latter muscle is retracted inwards and the outer border of scalenus anticus is identified. The phrenic nerve is found running down upon the muscle postero-external to the carotid sheath. The nerve is cut, the upper end is crushed and the lower end grasped in artery forceps, and pulled upon steadily and gently. By gradual traction very long lengths of the nerve may be dragged up out of the thorax, often the whole nerve being brought away. This avulsion is essential as a mere section of the nerve leaves intact the accessory branch from the fifth root via the nerve to the subclavius, which joins the main nerve within the thorax; local anæsthesia may well be employed for this operation on the nerve.

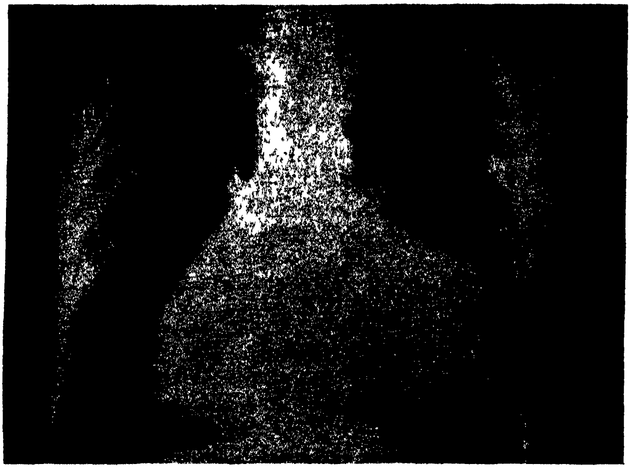


FIG. 155. Large hydatid cyst in the base of the right lung subsequently removed by operation. The picture is taken from behind.

Other operations which have been employed in phthisical cases without much success are section of the first rib in apical cases, Wilm's operation (see p. 453), which does not produce enough collapse, incision and drainage of tuberculous cavities, excisions of infected portions of the lung, and ligature of the pulmonary artery for hæmoptysis. With the exception of the last operation, which has met with one or two remarkable successes, these other proceedings are not recommended.

In order to produce further collapse of the apex, the operation of phrenic avulsion may be supplemented by a section of the scalene muscles. This is easily done through the same incision (*Scalenotomy*).

Hydatid Cysts of the Lung and Pleura. The lung is the second commonest organ in which hydatid cysts are seen, the total number found in the lung representing about 10 per cent. of the whole. They are not often seen in this country, and hydatids of the pleura are exceedingly rare. The lung reacts differently in their presence to the way in which the other organs do, in that it does not give rise to the formation of a fibrous ectocyst around the true cyst itself, the only evidence of irritation of the lung tissue being an increased vascularity. In the pleura, however, a hydatid cyst does give rise to an ectocyst. Such a cyst may grow rapidly and is particularly liable to rupture into a bronchus ; this accident sometimes will cause the death of the patient from drowning. Occasionally such a rupture gives rise to a spontaneous cure, but more frequently the cyst becomes secondarily infected, leading to an abscess of the lung. The symptoms of such a cyst are usually a chronic cough, slight mucoid expectoration, and a certain amount of pain from irritation of the pleura, while the physical signs indicate the presence of what appears to be a stony dull, solid body or large mass of consolidated lung tissue.

Eosinophilia is frequently present, as is also a positive Casoni intradermal test and complement-fixation test, while the X-ray appearance is usually characteristic. On no account must a cyst in the lung be aspirated with a hollow needle, except on the operating table when the chest is opened, as there is great danger of rupturing it into a bronchus and drowning the patient. Though a small hydatid cyst may be left alone, as soon as there is definite evidence that it is increasing the chest should be opened and the cyst exposed with the aid of an intratracheal anæsthetic, as this will prevent the patient from drowning should the cyst unexpectedly rupture. The cyst may be opened and the endocyst can as a rule be easily detached and removed, the same precautions being taken to ensure that the two pleural layers are adherent as are taken in the case of an abscess in the lung (see p. 451). The cavity that is left will need drainage for five or six days, after which time it should be obliterated gradually as the lung expands.

Emphysema of the Lung. Attempts have been made to benefit this condition by resection of small portions of several ribs close to the sternum, in an effort to restore mobility to the rigid chest wall, which is possibly the cause of the condition. Care must be taken not to open the pleura. The operation is not without danger, and its results are not very satisfactory.

Primary Growths of the Lung. Two main types of primary growth of the lung are encountered, and seem to be increasingly common, especially in aniline dye workers. The first or commoner class commence in the hilum and mediastinum and spread into the lung substance. The more rare ones originate from the epithelium of the smaller bronchi and alveoli and remain localised to the lung for a comparatively long period. These are rare, but they are the only ones in which surgical treatment is possible. These tumours are squamous-celled carcinomata (oat-celled), and they are symptomless until they begin to irritate the pleura or press upon and obstruct a bronchus. A description of their physical signs and symptoms belongs rather to the physician than the surgeon, and few at present are seen in an operable condition. Occasionally a tumour occurs in which the growth, as shown by an X-ray film, is confined to one lobe of the lung, and in such a case if the affected lobe can be removed it gives the patient a reasonable chance of recovery. The situation of such a growth can often be indentified by bronchoscopy and a piece removed thus for microscopic section. The only hope of finding growths of the lung in an operable stage lies in the early exploration of all suspicious cases, and by modern methods this is no more serious than an exploratory laparotomy.

Exploratory Thoracotomy. After a preliminary artificial pneumothorax the chest is opened between two ribs. An opening large enough to insert two hands can then be made by spreading the ribs apart: this is made even easier if a short piece is removed from the back of one or both of the ribs concerned. If necessary one or two ribs can be removed. The whole of that side of the chest can then be seen and thoroughly explored. The heart, great vessels, lungs and œsophagus are easily approached and visualised. If the operation is being done to remove a growth of the lung, according to the situation of the growth, the affected lobe is drawn up into the wound, and the vessels and the bronchus supplying it exposed by blunt dissection. The vessels are tied and the lung tissue at the base of the lobe is cut through, so that only the bronchus is left uncut. The bronchus is then crushed with powerful forceps, tied and divided, and its proximal end invaginated with a purse-string suture, the neighbouring portion of the lung being sutured over it. The wound is closed with drainage for two or three days.

The diathermy cautery will be found very valuable for cutting lung tissue or adhesions in this operation. An alternative method of performing this operation of *lobectomy* is described on p. 453.

Secondary Growths of the Lung. These are particularly common in connection with any form of malignant growth, especially sarcoma and carcinoma of the breast. They can be detected by an X-ray film as rounded opacities occurring in the lung, and always should be looked for before removal of any primary growth is undertaken.

DISEASES OF THE MEDIASTINUM

Acute inflammation of the mediastinum (cellulitis or abscess, **mediastinitis**) is usually due to the spread of acute infection from cellulitis of the neck, under the deep cervical fascia, or from ulceration of the œsophagus. This is a most serious condition and gives rise to a rapidly spreading mediastinitis or cellulitis, with high temperature and grave toxæmia. In other cases the condition follows a perforation of a carcinoma of the œsophagus or damage done by a foreign body impacted in the œsophagus, for such a foreign body may ulcerate through in a comparatively short time. Infections of the larynx, thyroid, ribs and lungs also may cause this condition. It is usually the anterior mediastinum which is involved, and in this case there will be pain behind the sternum and between the shoulder blades, with tenderness over the sternum and redness and œdema of the skin. Dyspnœa, cardiac irregularity and rigors may also be present. An abscess may form and burst through an intercostal space, or into the trachea, œsophagus or pleura. If the patient recovers, adherent pericardium (see p. 460) and interference with the heart's action may be the result.

Treatment. Drainage sometimes may be provided by opening the mediastinum by exploring downwards from the neck behind the sternum, while if the anterior mediastinum is infected, as shown by retrosternal pain and bulging intercostal spaces on either side, it may be drained by incising an intercostal space, removing a rib cartilage or trephining the sternum. In these cases the patient usually dies within a few days.

Large tuberculous abscesses are not infrequently seen in the posterior mediastinum as a result of spinal caries, or the breaking down of tuberculous mediastinal glands. These can be diagnosed at once by means of an X-ray film, and they may become sufficiently big and produce enough pressure to need relief. In some cases they point above the sternum, but such an abscess is generally best opened by the operation of *costo-transversectomy.* In this operation a vertical incision is made parallel to the spine at the outer border of the erector spinæ; the posterior portion of a rib is resected together with the transverse vertebral process with which it articulates. In this way the mediastinum is entered, the pleura pushed aside if necessary, and the abscess opened. This should be done preferably on the right side.

Growths of the Mediastinum. A variety of tumours occurs in the mediastinum: sarcomata, new growths of the thymus gland, retrosternal goitres (see p. 412), and occasionally teratomata; dermoid cysts are also found. These conditions will give rise to various signs and symptoms, according to which structures they press upon most. Many of these conditions are suitable for surgical treatment, and in not a few instances the sternum has been split longitudinally, the two halves retracted outwards, and an exploration of the mediastinum proved successful. It is always easy to insert radium into a mediastinal sarcoma by trephining the sternum, but the results are very uncertain, as are also those of deep X-ray therapy.

The Œsophagus. When the pleural cavity is freely opened and the lung collapsed a free examination of the intrathoracic part of the œsophagus may be made. In this way foreign bodies tightly impacted have been removed and growths of the œsophagus have even been resected, though there will be considerable difficulty in dealing with the severed ends of the tube (see p. 359). The œsophagus may be reached either (1) through the back of the mediastinum by an operation rather similar to that of costo-transversectomy, several ribs, with the transverse vertebral processes to which they are attached, being removed on the left side in the form of a flap, the pleura being pushed aside and the œsophagus exposed where it lies on the bodies of the vertebræ; or (2) it also may be exposed by collapsing the left lung by artificial pneumothorax and opening the left pleura between two ribs. (3) The œsophagus may be set free in the thorax and then cut and drawn up into the neck through another incision, being thus completely removed. The danger of all operations in which the œsophagus or bronchus are opened through or outside the pleura is sepsis, for the œsophagus has no serous coat covering it and the liability to a subsequent empyema or mediastinitis is great.

DISEASES OF THE PERICARDIUM AND HEART

Pericardial Effusions. These may be either *serous or purulent,* the former being seen in connection with many medical conditions, whereas the latter occur most commonly as a complication of acute osteitis (see Vol. I.). When the pericardium is distended with fluid it pushes aside the pleura and spreads upwards, tending to produce a forward rotation of the apex of the heart. The bare area of the pericardium, which is left uncovered by the notch in the left pleura and lung, will be increased, and the cavity may be aspirated, therefore, in the fifth intercostal space close to the border of the sternum or alternatively about 1½ inches to the outside of the sternum, so as to avoid the internal mammary artery. Aspiration is only to be adopted in the case of clear serous effusions which are causing considerable cardiac embarrassment, and in this connection it must be remembered that a pericardial effusion and a dilated heart may closely resemble each other. In both conditions the area of cardiac dulness is increased, dyspnœa and distress will be present, and the pulse be rapid and feeble. With pericarditis, however, the heart sounds will be muffled and a friction sound may have been previously detected, while the cardiac impulse will be greatly diminished. The dilated heart gives rise to a diffused impulse all over the area of cardiac dulness, while the heart sounds will be clear but of a tick-tack nature.

Suppuration in the pericardium is a most grave condition. Incision and drainage will be necessary here, and this may be accomplished readily by removing the fourth or fifth costal cartilage under local or general anæsthesia, dividing the triangularis sterni and thereby exposing the pericardium, which is opened freely, washed out and drained. This operation gives rise to a fair percentage of successes and should be undertaken as soon as possible on a reasonable suspicion that a suppurative pericarditis is present.

An alternative route, which does not give so good an exposure, is through the costosternal angle above the peritoneum, which is pulled down out of the way by a retractor, so that it need not be opened. The interval between the costal and sternal portion of the diaphragm is opened and the lower part of the pericardium exposed and drained. We, however, cannot recommend this method.

An alternative method of drainage of the pericardium when suppurative pericarditis is combined with a left empyema (as is not uncommon) is to drain the pericardium into the left pleura.

In some cases of pericarditis, after the pericardium has been opened and drained, it will be found that pus is retained behind the heart in the cul de sac of Haller, and when this is so, a tube may be inserted into it from the left side of the pericardium.

Pericardial Adhesions. As a result of previous pericarditis, the heart may become adherent to the pericardium covering it, and in this case adhesion of the latter to the chest wall, which often supervenes as the result of pericardio-mediastinitis, will interfere considerably with the cardiac movements. Embarrassment of the cardiac action is also caused by the pressure which the rigid chest wall exerts on a heart which is greatly hypertrophied as the result of valvular disease. For this condition the operation of **cardiolysis,** which consists of the removal of a portion of the chest wall over the heart, has been practised. This operation consists in removing the third, fourth and fifth left costal cartilages, sometimes with a piece of the sternum. The perichondrium also must be removed and the pericardium as far as possible set free. At a later stage the whole of the anterior wall of the pericardium may be removed and any large pericardial adhesions be divided in order to set the heart free. Many successful cases of this operation are recorded.

In some instances the pericardium and tissues round have become calcified. The calcareous plaques should then be pealed off and the heart, as it were, decompressed. These conditions are sometimes grouped under the heading of *chronic constrictive pericarditis.*

Cardiac Massage. A few cases of successful cardiac massage have been recorded in instances of sudden cessation of the heart's action or syncope under anæsthesia. The peritoneum is quickly opened in the epigastrium and the heart rhythmically compressed against the anterior wall of the thorax through the diaphragm. Some surgeons have made a practice of incising the diaphragm in order to do this, but this procedure is not necessary.

Surgery of the Great Blood Vessels. Two operations have been practised upon the great blood vessels. One main primary branch of the pulmonary artery has been tied successfully to check hæmoptysis in cases of phthisis or bronchiectasis. This operation is not difficult, the pericardium being exposed and opened by removing the second and third costal cartilages and the vessel tied, inside the pericardium, at the point where it leaves the serous sac. Gangrene of the lung does not follow, as the bronchial arteries are sufficient to preserve the vitality of the lung tissues.

The second operation is known as *Trendelenburg's operation*, and it attempts the removal of an embolus from the pulmonary artery in a case of pulmonary embolism. Suitable cases are rare, for death either occurs within a few minutes of the onset or, if the condition is less severe, recovery will take place with signs of a pulmonary infarct, and the only cases which should be subjected to it are those who live a few hours, but are obviously getting worse. Moreover, in many cases the condition is really one of pulmonary thrombosis rather than embolism. The operation has been performed successfully on animals, but so far in this country only one human case has survived more than fifteen days, although in Sweden several successful cases are alive and well. The base of the heart is exposed by removing two or three left costal cartilages, the pericardium is opened, and all the large vessels as they enter and leave the heart are temporarily clamped in one large special clamp. These vessels must not be clamped for more than ninety seconds, and during this time the pulmonary artery must be opened, the clot extracted with forceps, and the incision in the pulmonary artery closed with a temporary clamp. The clamp on the great vessels can then be removed so that the circulation is restored, and the clamped incision in the pulmonary artery can be sutured after this without hurry.

Operations on the valves of the heart for regurgitation are at present only in an experimental stage. Mitral stenosis has recently been treated by opening the left auricle through one of the usual cardiac incisions (see p. 460), inserting the finger, and cutting or stretching the valve. The auricle is then sutured, the inserted finger preventing any severe hæmorrhage during the operation. It is sometimes worth while converting mitral stenosis into mitral incompetence by performing a section of a valve with a direct vision valvulotome.

Angina Pectoris. Many attempts have been made to remedy this condition by surgical measures aimed partly at providing an improved blood supply for the cardiac muscle, and partly at relieving the intense pain. Sympatheticectomy, either in the form of a simple division of the left sympathetic cord between the superior and middle cervical ganglia, or that of complete removal of all these ganglia, is a rational proceeding and in some cases appears to have relieved the pain temporarily at any rate. Alcohol injection (85 per cent.) into the upper six dorsal roots has the same object in view. Thyroidectomy has also a sound theoretical basis in that it lowers the basal metabolic rate and may thereby compensate for the damaged state of the coronary circulation and diminish the amount of work required of the heart. A fair number of cases have been reported which show very marked improvement after this operation. Attempts to revascularise the myocardium have shown some measure of success. Thin portions of the pectoralis major have been grafted to the inner surface of the parietal pericardium, the inner surface of this and the epicardium being roughened to produce adhesion. In several patients this produced marked improvement. Pedicle grafts of omentum have been brought up through the diaphragm and sutured to the myocardium.

THE DIAPHRAGM

Injuries. Wounds of the diaphragm are usually due to gunshot wounds or stabs. The symptoms are generally those of associated injury to the thoracic or abdominal viscera. If the patient recovers, he is likely to develop a diaphragmatic hernia (see p. 462).

Rupture of the diaphragm is uncommon. It may be produced by a sudden increase in abdominal pressure as the result of crushes or muscular efforts in vomiting or parturition. It is usually on the left side, and cases have occurred where the rupture has been produced by an œsophageal bougie. The condition is likely to be accompanied by visceral injuries or displacements, and gives rise to much shock and severe pain on coughing or deep inspiration. Physical signs pointing to the presence of abdominal viscera in the thorax may be found, while it is said that risus sardonicus may be present in diaphragmatic lesions. Wounds and openings in the diaphragm get very little chance of healing and only form a thin, weak scar, on account of the continuous movements of the muscle, and thus the subsequent occurrence of a diaphragmatic hernia is very common.

The *treatment* of this condition should aim first at relieving any visceral injury which may be present. If possible the opening in the diaphragm should be sutured, either by the transpleural route or by the abdomino-thoracic method.

Diaphragmatic Hernia. This is a name which is applied to a bulging or protrusion of any of the abdominal contents through the diaphragm into the thorax ; as it does not as a rule consist of a true peritoneal sac, it is more strictly a prolapse. The condition is usually congenital, when it is due to imperfect development of one half of the diaphragm and is usually seen on the left side. In other rare instances the prolapse has occurred through one of the natural openings in the diaphragm, while in other instances it is the result of ruptures, stabs or wounds involving the diaphragmatic muscles. The reason why it is most often seen on the left side is that the support of the liver is lacking there, so that the omentum, stomach and transverse colon may prolapse into the thorax. The opening varies in size greatly and may occupy one-half of the muscle. Very few cases have been diagnosed during life unless they are strangulated ; such symptoms as there are are dyspeptic, due to the stomach disturbance, depression of the epigastrium, bulging of the left side of the chest, dysphagia and signs in the chest suggestive of a pneumothorax, while gurgling and intestinal sounds may be heard and the heart may be displaced. In many cases no symptoms or disturbance of health are present, though attacks of pain may occur due to nipping of the pylorus or cardia, so that the condition simulates a duodenal or gastric ulcer. X-ray examination with a barium meal will show the condition at once. Should the contents strangulate, the symptoms of a high-up, acute obstruction, together with puzzling chest symptoms, will appear.

When such a hernia is suddenly produced, signs and symptoms of a ruptured diaphragm predominate above all others (see above).

Treatment. If possible, an attempt should be made to return the prolapsed viscera to the abdomen and to close the aperture. This may be very difficult, and the best incision is a thoracico-abdominal one, which resects portions of the lower two or three ribs, opens the pleura, and also opens the peritoneum by pulling the left rectus outwards. Through a big vertical incision of this kind a fair exposure may be obtained and the diaphragmatic opening be closed.

As the pleura is opened freely, it is best to perform the operation by means of intratracheal ether.

Diaphragmatic pleurisy is an important condition for the surgeon, for it may resemble closely various acute abdominal conditions, such as acute cholecystitis, acute appendicitis, or perforation of a gastric ulcer. It leads to severe abdominal pain and rigidity, but the rigidity passes off momentarily at each inspiration, and the patient may complain of his breath catching him. At first very few signs may be present in the chest, and peristaltic sounds are normal on auscultation.

RESUSCITATION FROM DROWNING

Drowning is a form of asphyxia from immersion in fluid. The period of total submersion which is sufficient to render any possibility of recovery hopeless is very uncertain, but as one recovery has been reported in a patient who was said to have been submerged for twenty-five minutes, treatment always should be attempted.

The air passages, mouth, and throat must be emptied of water as quickly as possible by rolling the patient on to his front with the head lower than the body, and as the trachea probably will be full of a churned-up mixture of water, mucus, saliva and blood, this should be squeezed out as far as possible by pressing on the back while the patient is lying on his face. The mouth should be opened, the tongue drawn out, the clothing loosened, and warmth be applied in every possible way. The most important thing is artificial respiration, and this should be commenced as soon as possible without stopping to ascertain whether the signs of death are present.

Sylvester's method is not applicable in this case, as it is important to keep the patient prone, and not to turn him on his back at all; the best method, therefore, is **Schäfer's method.** To do this the patient is kept prone with the arms above the head and the face turned to one side, while the surgeon kneels astride of him, facing his head, and lays the palms of his hands on the lower part of the chest and loins, one on each side. He then leans forward so that his whole weight presses his hands firmly against the patient, thus compressing the lower half of the chest and forcing the diaphragm up. After continuing pressure for about two seconds the surgeon swings up and back and releases all pressure, whereupon the chest expands again, the diaphragm descends, and air is drawn into the lungs. These two movements should be repeated regularly to imitate the natural movements of respiration about sixteen times a minute. The resumption of natural respiration should be watched for, and when it commences the artificial movements should synchronise with it. This method causes a minimum of fatigue to the operator and should be kept up for an hour at least, unless natural respiration commences before this. Cardiac stimulants may be administered hypodermically, and as soon as the patient can swallow he should be given warm drinks.

TREATMENT OF POISONING BY GAS

See Vol. I., Appendix.

CHAPTER XII

THE BREAST

Surgical Anatomy. The breast is an organ which is developed in the skin and may be regarded as analogous to an extremely large sweat or sebaceous gland. It lies embedded in the superficial fascia over the chest and extends from the lower border of the second rib to the lower border of the sixth rib, and transversely from the outer border of the sternum to the midaxillary line. It lies upon the pectoralis major, serratus magnus and external oblique muscles, being separated from these muscles by the deep fascia (pectoral fascia). Its borders are ill defined and pass insensibly into the surrounding fat. From its upper and outer quadrant a tail-like process projects up towards the axilla and, in some cases, may reach right into the axilla as high as the third rib (axillary tail), passing partly under the pectoralis major. The breast consists of the parenchyma or gland tissue, a connective tissue framework, which contains the vessels and nerves, and the mammary fat, which surrounds it. It is divided for the purposes of description into four quadrants, the upper and outer, upper and inner, lower and outer, and lower and inner. Radiating in all directions from the breast are delicate fibrous processes, some of these, the suspensory ligaments of Cooper, being loosely attached to the skin over the breast, while others pass into the muscles and fascia under the gland. Over the centre of the breast is the nipple, surrounded by an area of dark-coloured skin, the areola, and at the apex of the nipple the milk ducts open.

The breast derives its blood supply from three sources : the long thoracic artery (external mammary), the perforating branches of the internal mammary and a few perforating twigs from the intercostal vessels. The nerve supply of the skin over the breast comes from certain descending branches of the cervical plexus and the lateral and anterior cutaneous twigs of the second, third, fourth, fifth and sixth intercostal nerves, while the gland tissue itself is supplied by the terminal branches of the third, fourth, fifth and sixth intercostal nerves.

Lymphatic Drainage. The cutaneous lymphatics draining the skin over the breast pass down in the septa of the subcutaneous fatty fascia to join an important plexus of lymphatic vessels running behind the breast in the pectoral fascia; the lymphatics from the nipple and areola also join this plexus, but on their way there pass through a small lymphatic plexus under the areola—*the subareolar plexus of Sappey.*

The vessels from the gland tissue run in the connective tissue around the lobules, also to join the plexus in the pectoral fascia, some directly, but the majority via the subareolar plexus. A few of the lymphatics from the inner half of the breast anastomose across the middle line with those of the other side, which will account for the permeation of carcinoma cells from one breast to the other—while other vessels from the lower and inner quadrant of the breast run down towards the epigastrium and communicate with those of the abdominal wall, peritoneum and liver, and this is probably the track by which carcinoma cells from the breast may reach the abdomen and liver. A few lymphatic vessels from the medial half of the breast pass through the intercostal muscles into the anterior mediastinum, a few others from the upper half of the organ proceed directly up over the clavicle to the supraclavicular glands in the neck, while there may be a small number of isolated lymphatics which run back along the intercostal vessels to the spine, but the vast majority of them pass directly to the axillary glands. These glands may be grouped into four sets :—

(*a*) The central—on the axillary artery, which receive vessels from the skin and periphery of the breast.

(*b*) The pectoral—lying under the top part of the pectoralis major and receiving vessels from the subareolar plexus.

(*c*) The subscapular—at the back of the axilla; these receive vessels from the lateral half of the breast.

(*d*) The subclavian—which lie at the apex of the axilla and receive a few lymphatics direct.

The breast is an organ which varies considerably in different persons, in size, shape, consistence and appearance, and these variations will depend upon whether the patient is fat or thin, upon her age, and whether the gland has ever functioned or not. In the young woman in whom the breast has never functioned, it is firm, smooth and rounded with thick, well-defined margins, and the nipple and areola are soft and rose-coloured in blondes, pigmented in brunettes. During pregnancy it swells, remaining soft and smooth, the veins over it become distended, and the areola and nipple become larger and darker in colour. After lactation it shrinks and loses its firm, rounded shape, becoming irregular in texture from deposit of fat and tending to become pendulous. After the menopause the secreting tissues undergo atrophy and the breast shrinks and becomes coarse and knotty on palpation. In the thin woman it becomes small and flattened out, but in stout subjects it is replaced almost entirely by fat and may become very big, prominent and pendulous. The whole breast always can be moved freely upon the underlying pectoral muscle.

To examine the breast properly the whole thorax, both breasts and both shoulders should be exposed, while the patient may be either standing or sitting, preferably the former. The breasts first should be inspected carefully, comparing the two sides, and noting especially any difference in their appearance or shape, or in the condition of the skin over them. The nipples also should be examined carefully and note taken as to whether either of them appears to be indrawn, retracted, or higher than the other. Should there be any apparent difference between the two nipples in any of these respects, inquiries should be made as to how long this difference has been present, as a long-standing retraction of the nipple probably has no pathological significance. The breast should then be palpated, and in doing this its size, shape and consistence are noted, both by picking it up between the fingers and also by pressing it firmly against the thorax with the flat of the hand. This latter method is most important, for many breasts seem thick and hard, and may appear even to contain an abnormal swelling when grasped in the fingers, but on pressing the breast substance with the flat of the hand the difference between thickened breast tissue and abnormal swellings will be detected at once. The skin over the breast must be examined carefully to see if it is thickened or altered in any way, to ascertain whether nodules are present, and to discover if it is abnormally adherent to either the breast tissue or any swelling that may be in the breast. If it is marked, adherence of the skin to structures underneath it often will be visible to the eye in the form of a puckered dimpled area, but in earlier cases it will be necessary to pinch up or stretch the skin in order to detect this adherence. If any abnormal swelling is discovered within the breast, its size, shape and consistence must be noted carefully, special attention being paid to whether it is hard, soft or fluid, to whether it is smooth or nodular and irregular, to whether it is of uniform hardness throughout or hard in some parts and soft in others, and to whether it is tender or not. Careful examination must be made to see whether the swelling is adherent either to the skin or to the nipple, to the muscle or fascia underneath the breast, or to the remainder of the breast tissue. The first point can be determined by pinching up the skin. To detect the second feature the patient should be told either to elevate her arm above her head or, better, to press her hand firmly against her hip bone in order to make the pectoralis muscle taut. The breast and swelling should then be moved, both from side to side and up and down, and its mobility compared with that when the pectoralis major is relaxed. The degree of attachment of the swelling to the remainder of the breast tissue is important, and this can be ascertained by holding the breast firmly in one hand and attempting to move the swelling about separately. The axillary glands must be examined carefully by passing the fingers of the hand right up into the apex of the axilla and drawing them slowly down the chest wall, while it is well also always to note the condition of the axillary glands on the other side, of the supraclavicular glands on both sides, of the opposite breast, and of the liver. Inquiry should be made as to the last occasion when lactation occurred and as to the presence or absence of discharge from the nipple; the breast may be squeezed gently to see if any discharge can be forced out.

MALFORMATIONS OF THE BREAST

Congenital malformations of the breast are by no means uncommon. Absence of one or both breasts will be seen occasionally (**amazia**), and this is more common in the male; when it occurs, the sternal part of the pectoralis major is sometimes absent, while a portion of the chest wall and the whole upper limb may be under-developed. Absence of the nipple (**athelia**) is also sometimes seen, and this is more commonly bilateral; when this occurs the ducts of the breast open into a shallow depression in the areola. Occasionally the male breast becomes enlarged to approximately the size of the ordinary virgin breast (**gynæcomastia**). This overgrowth affects most commonly only the fibrous stroma, so that the breast is functionless; but very occasionally instances have been recorded where lactation occurs in the male. The condition is not infrequently accompanied by malformation of the sexual organs. If these male breasts are large and troublesome, they may be removed.

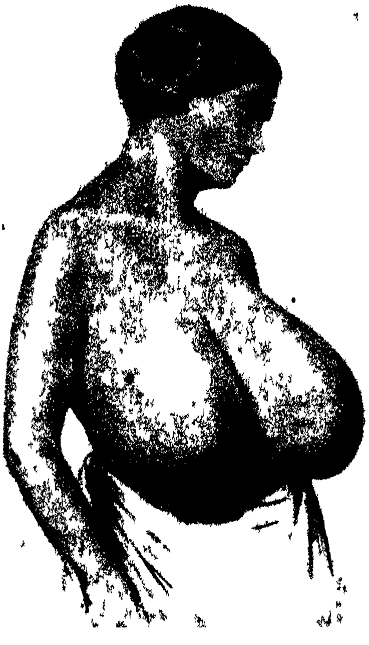


FIG. 156. Bilateral hypertrophy of the breasts.

The reverse condition, where the female breast never develops properly after puberty (**micromazia**), is occasionally seen, and this is often accompanied by imperfect development of the pectoral muscle and the sexual organs.

The presence of supernumerary breasts (**polymastia**) or of extra nipples (**polythelia**) is comparatively common, and is more often seen in the male than in the female, the extra organs being placed usually on the chest or the upper part of the abdomen, while they seem specially to be found along two lines running from either nipple down the abdomen and converging towards the pubic symphysis. They have, however, been seen rarely on the axilla, buttock, shoulder, or thigh. They are nearly always functionless, but have been occasionally the seat of carcinoma. No treatment is usually required, but if they are painful or the patient objects to them, they easily can be removed.

Diffuse Hypertrophy of the Breast. This is a condition which is commoner in the tropics than in this country, and consists of an enormous overgrowth of the breast, usually on both sides, the increase in size being due almost entirely to hypertrophy of the fat and fibrous stroma of the breast, the glandular tissue taking very little part in it. The breasts are usually painless and functionless, while the condition commences at or about puberty or during a pregnancy, and progresses slowly but steadily. In time the breasts become enormous, and they hang right down over the abdomen and even reach to the thighs. They are firm and elastic, and cause considerable trouble and inconvenience from their size and weight. No cause is known for the overgrowth, except that it is due probably to the action of some internal secretion, while in cases where the increase in size has been rapid a mistaken diagnosis of sarcoma has been made. The condition is frequently associated with a certain amount of anæmia and menstrual irregularity, and if it is allowed to go on indefinitely infection and suppuration of the breast tissue frequently set in. It must be remembered that this disease has nothing to do with true elephantiasis.

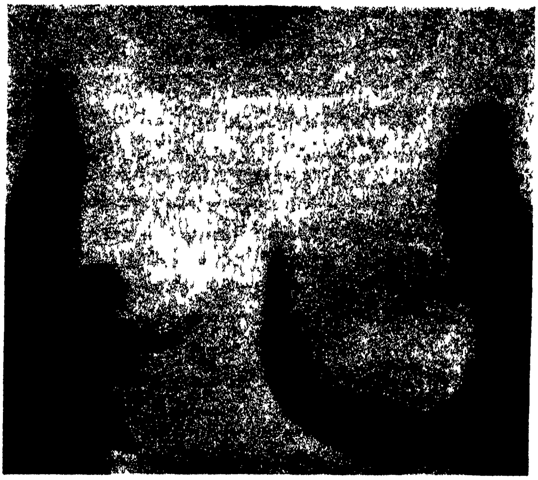


FIG. 157. Unilateral virginal hypertrophy of the breast in a girl of 16.

Treatment. In cases associated with pregnancy it is best to wait and see what happens when the pregnancy is over. In other cases no treatment is of avail except operation. In some early cases it may be sufficient to remove the upper half of the breast with a transverse elliptical area of the skin overlying it. On suturing the gap in the skin together the remainder of the breast tissue will be lifted up and supported. In most cases, especially the more advanced ones, amputation of the breast will be found necessary. As there is some evidence that when one of the breasts is removed the other tends to get smaller, it is best to be content with the removal of one only at first.

Injuries of the Breast. Bruises here are common; they are sometimes produced in infants by the uneducated by the process known as " breaking the nipple strings "; in adults badly-fitting corsets and direct blows often produce damage to the breast tissue. Severe bruises often will lead to extensive hæmatomata in the loose mammary tissues, and such a hæmatoma suppurates frequently and causes a mammary abscess. In other cases a mammary hæmatoma will encyst itself with a firm fibrous capsule and become converted into a chronic blood cyst. Stabs in the breast are common, especially in the left one; bleeding will be very free, and ligature of the vessels may be necessary. Foreign bodies are very occasionally seen in the breast; they are usually pins or needles, which may get into the breast by accident through having been stuck in the clothing; in other instances they are deliberately inserted by hysterical girls.

DISEASES OF THE NIPPLE

It is not infrequent to find that one or other nipple is abnormally small, depressed, or retracted. This is sometimes a congenital condition, but more commonly is the result of the scarring or puckering following a previous mammary abscess (see p. 472). In other cases a retracted nipple is strong evidence of a carcinoma of the breast underneath (see p. 493). In such cases suckling will be rendered difficult, though the nipple often can be pressed or gently drawn out, or sucked out by the breast pump, while the presence of such an abnormality will render the nipple specially liable to the onset of cracks, fissures and infection (see below).

Cracks and Fissures of the Nipple (chapped nipple). These are hardly ever seen except during lactation, and are caused either by want of care and cleanliness, the nipples being left damp after suckling, or else are due to eczema of the nipple and areola, or to small injuries produced by the child in sucking. The skin in this neighbourhood is exceedingly delicate, and, as a result of the continual moisture and the irritation of suckling, such a crack rarely will heal until nursing is discontinued. The epithelium of the nipple may become rubbed off and the deeper tissues become inflamed, while infection is highly likely to get in, and will then spread in many cases to the breast along the milk ducts or lymphatics and set up acute mastitis (see p. 472); in other cases the organisms spread to the axillary glands. Nursing often will become so painful that the mother will desist from it, and the breast will then become engorged with milk, which will render it additionally liable to infection. If the whole nipple is inflamed it will become rigid, swollen, red, tender and œdematous. Cases are occasionally seen where lactation is not present and the nipple has been rubbed and excoriated by the clothing or by handling.

Treatment. This in the first instance is prophylactic. During the last few weeks of pregnancy the nipple should be kept clean by washing with a mild antiseptic solution and hardened with alcohol or eau de Cologne, and immediately after nursing it should be washed with a dilute antiseptic lotion such as boracic acid, carefully dried, and dusted with boric acid powder and starch. When a fissure has formed, an artificial nipple may be worn, but it is better, if possible, to discontinue the use of that breast for a short time, and keep it emptied by means of the breast pump. The fissure should be dressed with lotio plumbi or a mixture of equal parts of glycerine and sulphurous acid. Any infective condition of the infant's mouth must be carefully attended to, while care must be taken that the corsets do not press upon or irritate the nipple. If small chronic ulcers persist and refuse to heal, they should be touched with silver nitrate.

Eczema of the Nipple. This is a not uncommon condition, especially in connection with cracks and fissures of the nipple, and in many cases it is a simple eczema, due probably to local irritation and giving rise to a small amount of sticky discharge, which rapidly dries. Its treatment is that of eczema on any other part of the body.

Paget's Disease of the Nipple (Dermatitis Maligna). This is a condition somewhat similar to the above, consisting in an eczematous condition of the nipple and areola, which is invariably followed sooner or later by the development of cancer in the breast underneath. It is thought that the condition is due primarily to a carcinoma, which appears first in the breast underneath, and is not noticed or remains latent until the eczema, which is secondary to it, has been present for some time; and the probability is that the permeation of the subcutaneous lymphatic vessels by the carcinoma cells (see p. 490) interferes so much with the lymphatic drainage of the skin round the nipple that the eczematous condition is the result of the lymph stagnation. Other theories are that the condition is a primary carcinoma arising in the deeper layers of the dermis of the nipple, or that the eczema of the nipple is the primary condition, and that the carcinoma is the result of the irritation to

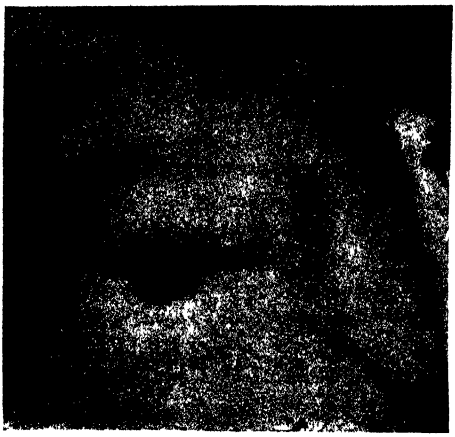


FIG. 158. Early stage of Paget's disease of the nipple.

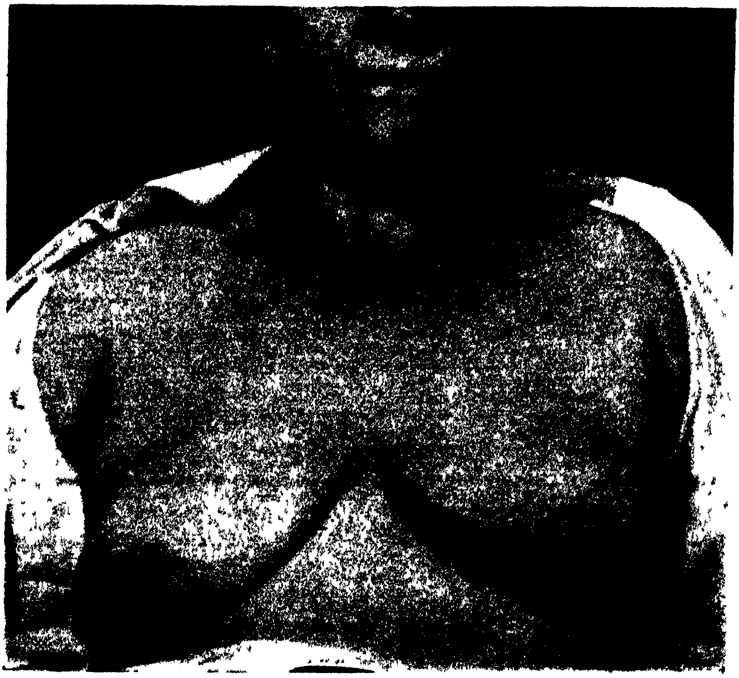


FIG. 159. Paget's disease of the left nipple, which has been almost completely destroyed and is replaced by a raw red area.

which this gives rise. Microscopically the stratum Malpighii and the corium are both proliferated, and some of the milk ducts will be found to be plugged with this proliferated epithelium, while occasionally masses of large multinucleated transparent cells, the characteristic Paget cells, are found in the infiltrated tissues. The condition is very rarely seen on the skin elsewhere, such as the thigh or glans penis.

Clinically we find the condition in women, usually between forty and sixty, and the eczema of the nipple persists for six months or a year or more before any swelling is felt in the breast underneath. The nipple and areola become red and covered with small scales, which, when detached, leave excoriated areas, so that sooner or later there is an extensive red, smooth area with no vesication or itching, and discharging a yellowish fluid which dries and forms fine crusts. Ultimately the nipple more or less completely disappears and a flat, bright red, weeping surface is left, of a peculiarly florid colour, which may spread on to and beyond the areola. The discharge is sometimes very copious and forms large crusts, while in other cases it is drier, and the skin, when picked up by the fingers, feels tough and parchment-like. The axillary glands become enlarged, and sooner or later a lump with the characteristic appearance of a carcinoma will appear in the breast underneath, usually close to the nipple. This carcinoma is rarely a duct carcinoma (see p. 499), and it runs the characteristic course of a malignant growth of the breast.

FIG 160. Epithelioma of the nipple in a girl of 11. This had been present 10 weeks.

Treatment. No local treatment for the eczematous condition of the nipple has any effect upon the condition, nor would it be right in principle. The treatment therefore consists in removal of the breast on exactly the same lines as for carcinoma, and this should be done, if possible, even before any palpable lump appears (see p. 502).

Primary Chancre of the Nipple. This condition is seldom seen in the mothers of syphilitic children, in accordance with Colles' law (see Vol. I., Ch. VI.), but it is not uncommon on the nipple or areola of healthy women who have acted as wet-nurse to a syphilitic infant. It is sometimes seen on both nipples, while the chancre itself is occasionally multiple; it is usually atypical and gives rise to a shallow ulcer or fissure, with a hard indurated border, which appears in the course of very few weeks. The axillary glands are always enlarged, and they may form big, firm, discrete, tender masses Characteristic secondary lesions will appear soon.

The treatment is that of syphilis in general (see Vol. I., Ch. VI.).

Tumours of the Nipple. These are rare, but epithelioma, papilloma, fibroma, angioma, and melanotic carcinoma have all been described, and run the same course here as elsewhere in the body (see Vol. I., Ch. VIII.).

In the areola it is not uncommon to see small sebaceous and lymphatic cysts. These occasionally suppurate and give rise to small subcutaneous abscesses.

DISEASES OF THE BREAST

Certain conditions are met with in the breast which may be regarded as being on the border-line between pathological and physiological processes, as they all have an intimate connection with the development and function of the breast.

It is not uncommon soon after birth for the infant's breasts to become slightly swollen and tender, while a little secretion may flow from the nipple.

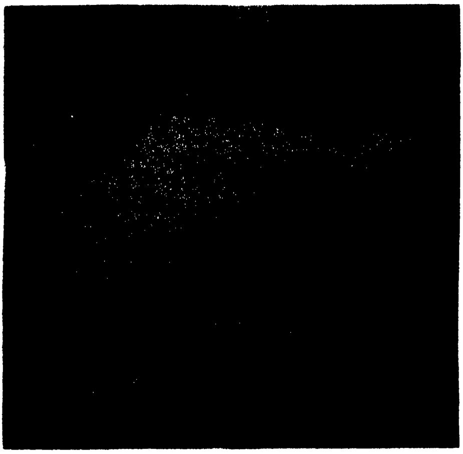


FIG. 161. Acute mastitis neonatorum.

This is known as **mastitis neonatorum**, and was at one time thought to be due to the old-fashioned midwife's habit of "breaking the nipple strings." This has probably nothing whatever to do with it, and the condition is due to the epithelium of the ducts undergoing an active proliferation as a preliminary to the development of the breast. It is possible that in some cases the condition is due to infection of the ducts with organisms derived from the mother during birth. No treatment is required unless suppuration sets in, and this is uncommon. If this complication occurs, a simple incision will be required.

Later in life, between the years of ten and fifteen, a further development in the breast tissues occurs, and for the first time the acini show their appearance. This process is at times accompanied, sometimes in boys, but more often in girls, by one or other breast or a portion of the breast becoming hard and tender and giving rise to a firm, rounded, movable painful swelling, like a tender flat button, the so-called **mastitis of puberty.** The condition will resemble closely a fibro-adenoma, but is more tender and appears more rapidly. The mother is often alarmed about it, but it is of no importance and requires no treatment, though it takes some weeks to subside. Should any treatment be decided upon, it will be the same as that for chronic mastitis (see p. 475).

During pregnancy a great increase in the breast development will take place, and the breasts will become engorged, hot and tender, while during lactation, quite apart from the acute inflammatory conditions which may set in (see below), retention of the milk (**milk engorgement**), due to blocking of the ducts from congenital or other causes, or because the child does not suck properly, will occur often. In this condition the breast becomes swollen, dusky and painful, the veins are prominent, with great tenderness of the whole or part of the breast, while the temperature is often raised 2 or 3 degrees. The condition must be distinguished carefully from acute mastitis or mammary abscess (see below), to which it often may be a preliminary. It will be found that withdrawing the milk with a breast pump and the administration of magnesium sulphate, potassium iodide and belladonna soon will clear the condition up, providing infection has not also occurred.

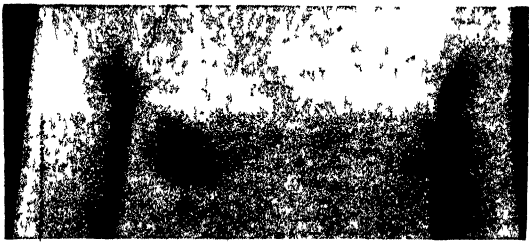


FIG 162. Mastitis of puberty in the right breast of a girl of fourteen.

Again at the menopause, both chronic interstitial and cystic mastitis will be found to be intimately connected with the degenerative changes occurring in the breast at this period.

In connection with mumps and other acute specific fevers an attack of transient, acute non-infective mastitis will occur often. This will clear up without treatment in most cases, though suppuration has occasionally set in. The condition is sometimes called *metastatic mastitis*.

Acute Infective Mastitis and **Mammary Abscess.** Acute infection of the breast with pyogenic organisms (usually the Staphylococcus aureus) is seldom seen except during lactation, when it is frequent. Engorgement of the breast with milk is a most important predisposing cause, and it may be regarded almost as a first stage of the condition. The organisms gain access to the breast tissues by way of the periductal lymphatics, and frequently this is rendered possible as the result of a cracked nipple, while obstruction to one or more of the ducts, often from inflammation of the nipple, also will give rise to the condition. The infection will commence either in the interstitial tissues or be intracanalicular, according to whether the lymphatics or the ducts are chiefly involved, and pus, if it forms, will appear first in corresponding situations. Streptococcal cases are occasionally seen, and here the infection almost invariably gets in through an abrasion of the surface of the nipple, and tends to involve the lymphatic rather than the glandular tissues. Apart from lactation, acute mastitis will arise also as the result of an injury, being then usually due to the infection of a hæmatoma, while pyæmic cases are occasionally seen. The special forms, mastitis neonatorum, puberty mastitis, and metastatic varieties, are considered on p. 471.

All forms of acute infective mastitis, especially those occurring during lactation, are very liable to result in suppuration and the formation of one or other form of mammary abscess.

Clinical Features. In acute mastitis the breast first becomes swollen, acutely painful, and tender. The lobules may be felt in the form of tender nodules in the breast, while as the mother is unable from the pain to continue to suckle the child, there will be a considerable degree of milk engorgement also. The temperature will be raised, the skin over the breast will become red, the axillary glands will be large and tender, and there will be considerable malaise and general constitutional disturbance. All these signs may be present without suppuration having occurred, and in many cases, with suitable treatment, suppuration can be avoided. In some cases the condition is diffused throughout the whole breast, but often, as it advances, it will be found to pick out one or more lobes and give rise to red, hot, tender sector-shaped swellings. It must be remembered that the milk from such an infected breast will be full of cocci, and if the infant is allowed to continue sucking from this breast it is almost certain to suffer from various forms of enteritis.

Suppuration often, however, sets in, and when this occurs the skin becomes redder, or of a dusky purple colour, œdema becomes marked, while the pain and tenderness, fever, and constitutional disturbance are all increased. Shivering and a swinging temperature often will occur, and the patient may state that the pain is lancinating or throbbing. The swelling becomes more localised, and at its most prominent and tender spot fluctuation may be detected.

Mammary Abscess. If suppuration sets in an abscess will form, and this may occur in three different situations.

(*a*) **A Supramammary Abscess** (Subareolar abscess). This is the name given to an abscess under the skin or nipple, but superficial to the true breast tissue. It may arise from an infection of the superficial lobules of the breast, but frequently it has no connection with the breast at all, in which case it is due to a subcutaneous cellulitis or to suppuration in a sebaceous gland. Pus is formed quickly and does not burrow far, but soon bursts on to the surface, so that the abscess is usually small and pain and constitutional disturbance are slight.

(*b*) **An Intramammary Abscess.** This is the commonest form, and is the result of the formation of pus within the breast substance, the condition either being diffused throughout the whole breast or sometimes remaining localised to one or more lobes. An actual gangrene of the breast tissue sometimes occurs in connection with this in feeble and debilitated patients. The symptoms are those of an acute mastitis at first (see above), and when this condition has been present for one or two days, the presence of pus will be shown by the pain becoming throbbing and constant, the temperature becoming higher and swinging, and the onset of leucocytosis and rigors, while in the breast itself a deep, localised tender swelling appears, the skin over which becomes œdematous, dusky and purple, and the swelling itself gradually softens until it fluctuates. When the pus forms deep down in the breast it will burrow widely in different directions, and the result is frequently an irregular loculated abscess cavity. If left untreated the ultimate result will be that the pus will find its way to the surface and burst out, either below the breast or near the areola, and before this occurs the abscess sometimes assumes the shape of a collar stud, with superficial and deep parts connected together by a narrow track. Occasionally in anæmic and weakened women, or as the result of pyæmic or septicæmic infections, such a condition will occur in both breasts.

The scarring and puckering of the breast to which this condition gives rise years afterwards may resemble closely a carcinoma of the breast.

(c) **A Submammary Abscess** (retromammary abscess). This occurs behind the breast in the cellular tissue between it and the pectoralis major. Though sometimes due to the acute mastitis of lactation, it is more common for this to occur as the result of infection of a hæmatoma following an injury to the breast, while in many cases it is not connected with the mammary organ at all and is due to an empyema which has pointed through the chest wall, or is a cold abscess due to tuberculous caries of the ribs or spine (see p. 440). In other instances it forms part of a diffuse cellulitis of the chest wall, also unconnected with the breast. When such an abscess occurs, the whole breast is pushed forward and appears as a conical swelling floating on a bed of pus, while fluctuation may be detected round the outside of the breast. The abscess usually in time points and bursts at the outer and lower part of the breast, while occasionally it tracks into the axilla.

Treatment of Acute Mammary Infections. This depends entirely upon whether suppuration is present or not. In the early stages, before pus has formed, and even when its formation is threatening, efforts should be made to prevent suppuration if possible, and these often will be successful. Suckling on the affected side must be stopped, and the milk should be drawn off as required by the breast pump, while active hyperæmia should be encouraged by the application of dry heat and a large Klapp's suction bell. This bell is applied for about an hour twice daily and the suction increased until it just becomes painful. In between the suction the breast should be supported gently with a bandage and the arm carried in a sling to keep the pectoral muscles at rest. The bowels should be opened with magnesium sulphate or other salines, whilst the administration of potassium iodide, belladonna, quinine or iron have all been recommended.

If suppuration seems inevitable, hot fomentations may be applied until the pus has definitely formed, but when this has once occurred there should be no hesitation in freely opening the breast and draining the abscess, while the case must be treated with the most rigid aseptic precautions to prevent the occurrence of a mixed infection. In the case of a supramammary abscess the pus is immediately under the surface, and a small incision in any direction will suffice, but in the intramammary form it is important that incisions should radiate from the nipple in order to avoid cutting the ducts. Inasmuch as these abscesses have loculi running in different directions, and not infrequently consist of a superficial and deep portion connected by a narrow track, the incisions should be free and deep, and the gloved finger should be inserted into the abscess and all septa and loculi be broken down. Counter-incisions at the lower part of the breast frequently will be necessary, and one or more large drainage tubes should be inserted. These tubes should be shortened gradually from day to day and should be removed as soon as it is considered safe, to lessen the liability to sinus formation; in any case, they must be removed within five or six days. Bleeding may be profuse and should be controlled by packing the wound. After the operation the wound should be dressed with hypertonic saline or antiseptic dressings.

In most cases healing occurs, and the breast is restored approximately to its normal shape, with very little deformity, but sometimes it will be found that discharging sinuses will persist, especially in those cases where the abscess has burst spontaneously, or where the incision is not at the lowest point of the abscess. If this should occur, the sinuses should be slit open, curetted and gently packed with antiseptic gauze. In other cases a portion of the breast or the whole breast will be riddled with sinuses and appear to be completely disorganised, and if this is so, the portion or the whole of the breast will need removal.

A submammary abscess is best opened at the lower and outer side of the breast, the breast being turned upwards like a flap until the pus is reached, when a tube can be inserted. If, however, the submammary abscess is tuberculous and connected with a carious rib, the treatment will be quite different (see p. 440), as it will involve the question of dealing with the carious bone.

Chronic Mastitis. This condition presents itself in several different forms, and has received many different names, such as chronic lobar mastitis, chronic lobular or interstitial mastitis, fibrocystic mastitis, etc., but there is no doubt that the pathological processes underlying these conditions are all the same, and the difference in appearances are to be explained by the different ways in which the portions of breast affected react. Some authorities even have regarded the more truly physiological processes in the breast, such as mastitis neonatorum and the mastitis of puberty, as examples of this condition. Others prefer the name Mazoplasia, as there is usually no suggestion of true inflammation in the condition.

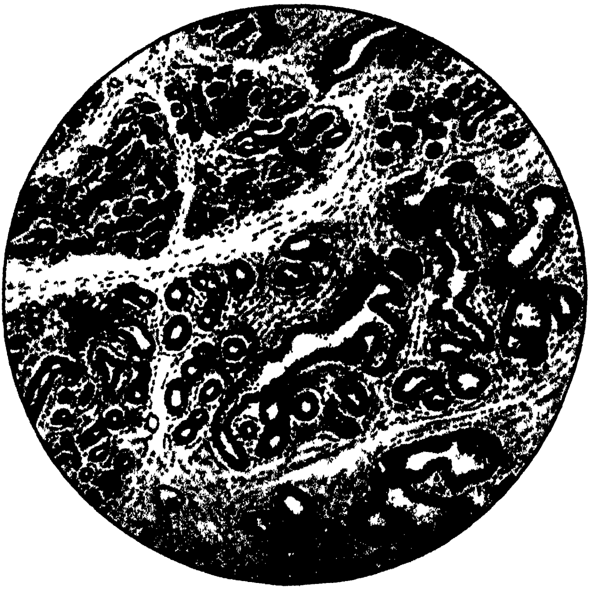


FIG. 163. Chronic hypertrophic mastitis under a low power.

The ætiology of this disease is unknown, but there is no evidence that it is in any way due to an infection, and it is probable that it is connected with the changes which occur in the gland in connection with the involution of the breast after lactation and towards the end of reproductive life. It must be remembered that the breast is throughout life an organ which is always either extremely active or completely quiescent, but the fact that the disease occasionally occurs in men, and is not infrequent in either sex as a result of a blow, shows that it is not due simply to changes connected with functional activity; in some instances there is evidence that the condition is caused by various toxic blood conditions (intestinal stasis, etc.). The condition is most commonly seen in women with small breasts approaching the climacteric, but it is by no means uncommon in younger women, especially the unmarried, and it may involve one or both breasts; it is notably frequent after pregnancy has been interrupted in cases of abortion, etc. The first change noticed consists in an overgrowth and increase of the connective tissue surrounding the lobules and acini, and this fibrous tissue squeezes and compresses the acini and ducts so that they atrophy. The ducts especially become occluded, both by the strangulation of the fibrous tissue and by becoming blocked by the débris of epithelial cells cast off from their own lining and that of the alveoli, and thus the unobliterated portions of the ducts above the obstruction become dilated and distended with fluid to form retention cysts. These cysts may be single or multiple and vary in size from a pin's head to a walnut, containing either a clear watery or a thick brownish fluid. They are usually lined by epithelium, which in the smaller ones is apparently the normal epithelium of the breast; but in others marked evidence will be seen of great proliferation of the epithelium, and this proliferated epithelium sometimes will fill the alveoli more or less with a thick cheesy or grumous material. The microscopic section may closely resemble a fibroadenoma, but the presence of fat in the section quite close up to the alveoli will distinguish between the two. There is no doubt that in a proportion of cases this chronic cystic change with epithelial proliferation can undergo a malignant metamorphosis, and it therefore must be regarded as a pre-cancerous condition when definite cysts are present. If there are no cysts it is probably not pre-cancerous.

Clinical Features. The clinical features will depend largely upon how advanced the changes are, and whether they are diffused throughout the whole breast or confined more or less to one lobe. The condition is usually seen in women approaching the menopause, although it is by no means uncommon between the ages of thirty or forty, or even younger. It is quite common in the married and unmarried, and in the multiparous and nulliparous. In some cases there will be a history of a blow on the breast a short time previously, and in the cases which occur in men this is almost invariable. The patient usually complains of discomfort in the breast, with neuralgic shooting pains and tenderness, the pain being often worst at menstruation, and said to shoot through into the shoulder and down the arm. The disease often causes the patient a good deal of worry and anxiety, and this will especially be the case in those who have themselves noticed a lump in the breast. On examination of the breast several conditions may be found; most commonly, especially in the cases over forty, the tissue of one breast or both breasts will be found to be firm and have a coarse, knotty or gritty feel, best appreciated by picking it up between the fingers and thumb. Small, rounded elastic swellings will be detected all over it, which are sometimes specially tender, and these are usually minute cysts; this variety of the disease is the condition known as **chronic lobular interstitial mastitis.** In other cases the breast will have quite a different appearance, there being a localised area of mastitis confined to one or more lobes, and giving rise to a tender sector-shaped hard lump, which, however, becomes less noticeable when palpated with the flat of the hand. Such a mastitic lump is nodular, indurated and painful, while it may have a very slight amount of adherence to the skin and retraction of the nipple associated with it. Rare cases have been described in which there has been a scanty serous discharge from the nipple. This is the form of the disease known as **chronic lobar mastitis,** and even in this form it usually will be noticed that, in addition to the localised lump in the breast, the remainder of the breast tissue has undergone a certain amount of interstitial change also, as is shown by its coarse and granular feel. The third change seen in the breast in this condition is the formation of a **single big cyst.** This is not uncommon, and it gives rise to a very hard, tender swelling, usually near the nipple, and which is often too tense to give a sense of fluctuation. It must be remembered that all chronic mastitic swellings are intimately adherent to the remainder of the breast tissue, are not attached to the underlying muscle or fascia, and only show at most the very slightest degree of attachment to the overlying skin. They are nearly always accompanied by enlarged lymphatic glands in the axilla, which are big and tender, but never hard and fixed.

If the disease is left to run its course untreated, a few cases will undergo a spontaneous cure, but it is much more common for the process to result in either (1) a general atrophy and fibrosis of the breast, (2) a diffuse cystic change which converts the organ into a number of cysts, or (3) a malignant change supervening, and there is a very definite risk of this in patients over forty in cases of cystic lobar mastitis: lobular mastitis on the other hand shows little tendency to undergo a malignant change. It must not be forgotten that as the result of any irritation in the breast areas of chronic mastitis will appear, and it is therefore not uncommon to find that other diseases of the breast, such as fibro-adenoma or carcinoma, are surrounded by small areas of mastitis, due to the irritation of the tumour. When this occurs it may render differential diagnosis very uncertain.

Diagnosis. Those cases where there exists a diffuse shotty condition of the breast are easily recognised, but the ones where there is a solitary mass or solitary cyst may be mistaken easily for a fibro-adenoma or carcinoma. However, even if a cyst is so tense that it does not fluctuate, its fluid nature often will be demonstrated by means of Paget's test, which consists in observing that whereas a hard, solid tumour is hardest at its central or thickest part, a hard tense cystic swelling is softest as its central and thickest part, while it must be remembered in general that cysts are more nearly spherical and are smoother to the feel than new growths. Other points of distinction between chronic mastitis and growths are the facts that in the former the whole breast or both breasts are diffusely involved, the axillary glands are less hard and more tender, that the tumour is not adherent to the pectoral muscle, nor is it stony hard, while on palpation with the flat of the hand the mastitic tumour becomes less obvious, as it merges into the surrounding tissues in a way which never occurs in a scirrhus. Mastitic swellings are also usually far more tender than growths, which are painless. Nevertheless in a fat breast cases will be seen in which it is absolutely impossible to make a certain diagnosis without aspirating the swelling with a hollow needle or making an incision into it. There should be no difficulty in distinguishing a fibro-adenoma (see p. 483), as this appears to move about freely within the breast substance and is not associated with enlarged axillary glands. If there is any doubt whatever about the diagnosis, an exploratory operation is urgently demanded.

Treatment. In a woman under forty, if one can be certain that the condition is not malignant, it is justifiable to treat it at first by non-operative measures. These consist in the application of a belladonna plaster or a Scott's dressing, together with a firm bandage to support the breast, and the removal of any local irritation, such as badly-fitting corsets. Firm pressure alone from a bandage, if kept up day and night, will often be very beneficial. Iodide of potassium by the mouth will be found beneficial, while occasionally small quantities of thyroid extract or ovarian or testicular hormones will help; Klapp's suction bell or an ordinary breast pump is also extremely valuable, while the use of deep X-ray therapy or a radium plaque may effect a cure. If the condition does not speedily improve under this treatment, or in all cases over the age of forty where a definite tumour is present, or if on microscopic examination cysts with proliferating walls are found, it is wise to remove the disease by operation. In some cases, where it is sharply localised, it is possible to remove a quarter or half of the breast containing the mastitic portion, but inasmuch as it is essentially a general disease of the whole of the breast, in most cases it will be found better to excise the whole organ, there being, of course, no need to remove the axillary contents or the pectoral muscles.

Encysted Chronic Abscess. A cold abscess is occasionally seen in the breast which is not tuberculous. Sometimes this will occur during pregnancy, but often it is independent of this, when it may be due to infection of a haematoma or of a pre-existing retention cyst, while in other instances it is due to the remains of a previous acute abscess, or may follow upon an acute attack of mastitis which has not suppurated, but which has passed into a chronic state. Clinically it will manifest itself as a slowly increasing, indurated swelling, which soon softens and which will give rise in time to fluctuation, though inasmuch as it usually has a very thick and tough wall, this sign often may not be detected. The swelling is tender and painful; there may be a purulent discharge from the nipple, which is often retracted, while the axillary glands will be large and tender. The condition may resemble a new growth closely, but it is less sharply defined, and Paget's test (see p. 477) will prove it to be fluid. The diagnosis can, of course, be settled by aspiration, but in many cases the pain and tenderness, the history and the elasticity will serve to distinguish it from a carcinoma.

FIG. 164. Cold abscess in the left breast.

Treatment. This consists in cutting down upon the abscess and, if possible, dissecting it out, after which the breast tissue should be sutured together. Frequently this cannot be done, and in that case it should be opened, its wall gently curetted and swabbed with pure carbolic, and a drainage tube inserted. If the condition appears to be tuberculous, the whole breast should be removed (see p. 479).

Tuberculosis of the Breast. This is a rare condition, in which the organisms usually reach the breast via the blood stream, though occasionally it is directly infected from the ribs, sternum or lungs; in this latter case there probably will be a submammary cold abscess (see p. 474) on which the breast rests, and from which it becomes infected. It is possible in some instances that the infection gets into the breast by passing up the nipple through one of its ducts.

The organisms are deposited in the interalveolar tissue, and give rise to scattered deposits of caseous matter, diffused throughout the breast, which break down and suppurate, and sometimes these will coalesce to form one big cold abscess. One or more sinuses will result ultimately and the breast becomes more or less riddled with tuberculous débris and pus. Sooner or later the axillary glands will in their turn become tuberculous also. This condition is usually seen in women between fifteen and thirty-five, who frequently also suffer from phthisis. It is four times as common in the married as the unmarried and is practically unknown in males; it is commonly unilateral, painless and insidious, and by the time it is recognised the whole breast is usually swollen, tough and nodular, while, later, one or more areas of softening will appear, which will go on to form a characteristic abscess. Gradually the skin over the breast will become red and thickened, and in time it will give way and the pus come out at one or more points, the result of this being the formation of characteristic tuberculous sinuses with blue undermined edges (see Fig. 165). By the time this has occurred it will be found often that the breast is shrinking and becoming even harder and tougher than before from the increase in fibrous tissue, while the nipple is retracted and the axillary glands are certain to be enlarged and fixed, and also may be breaking down. In advanced cases the breast becomes adherent to the pectoralis major, which will be infiltrated itself with tuberculous tissue. There may thus be a marked resemblance to carcinoma.

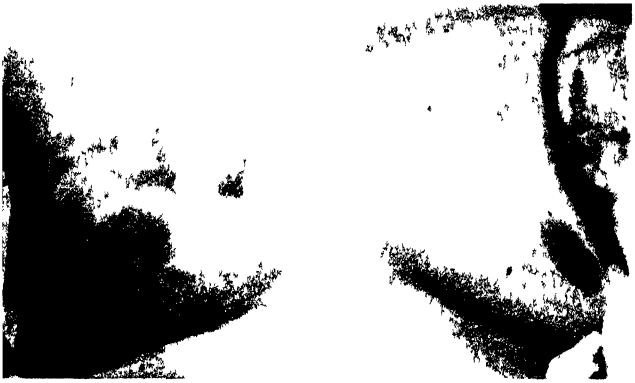


FIG. 165. Tuberculosis of the breast in a lady of twenty-six. It had been present six years.

In some cases the axillary glands are so much enlarged that they are regarded as the primary condition, the state of the breast not being noticed.

Treatment. This consists in the usual general treatment of tuberculosis combined with removal of the breast, the nipple, the skin over the breast, and the axillary glands; the muscles need not be removed or interfered with.

In many cases, where the patient has advanced lung disease, operation on the breast obviously will be contra-indicated.

Actinomycosis. This is occasionally met with in the breast, where it is usually secondary to an infection of the lungs and chest wall. It has been described in the male breast, and in the very rare cases where it is a primary condition it is quite possible that the infection has got into the breast through the nipple. The clinical appearance and history is very similar to that of tuberculosis, except that it is even more chronic and produces more hardness and induration of the breast tissue, while the sinuses are almost invariably multiple, and the axillary glands are not usually involved at all. The discharge contains the characteristic sulphur granules, and the diagnosis is clinched by discovering the filaments of the ray fungus in it.

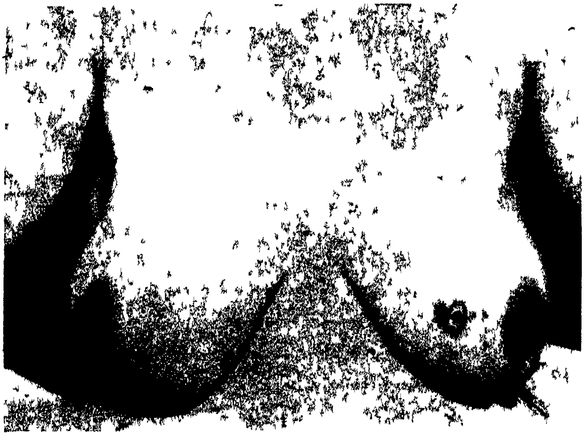


FIG 166 Actinomycosis of the left breast, showing multiple sinuses.

Should this be the only focus in the body, the whole breast should be removed, but this is unlikely, and in most cases the general treatment of actinomycosis (see Vol I , Ch. VI.) is all that can be done.

Syphilitic Affections of the Breast. This organ is very rarely involved in syphilis. Chancres are occasionally seen on the nipple (see p. 470), while rarely mucous patches or condylomata are found there or on the moist skin underneath a pendulous breast Very rarely gummata occur in the breast and give rise to one or more tough or indurated swellings, which slowly break down and form a characteristic gummatous ulcer. The treatment is that of syphilis in general.

Calcification of the Mamma. A very few cases have been recorded where calcification has occurred in the mamma, usually after a period of very chronic inflammation, which may have been tuberculous.

Neuralgia of the Breast (Mastodynia). Neurotic young women are occasionally seen who complain of intense shooting pains in the breast, especially during menstruation. Other disturbances of the sexual organs are often present, but the breast, on examination, appears perfectly normal, except that the patient states that certain spots in it are excruciatingly tender.

She should be assured that no growth is present and her general health be treated by tonics and general measures, while any associated uterine derangement should be set right.

It must not be forgotten that in *scoliosis* referred pain from pressure on the intercostal nerves may give rise to mastodynia, and in all cases where the breast appears normal with such symptoms, an examination of the spine must be made.

CYSTS OF THE BREAST

Many different forms of cyst are found in the breast, some of them in connection with the ducts and secreting alveoli, others arising in the fibrous supporting interalveolar tissues, while a large class is due to the cystic degeneration of new growths.

(A) *Cysts connected with the alveoli and secretory glandular structures.*

(1) **Retention Cysts.** These are due to an obstruction in a main duct which prevents the secretion of the organ escaping, so that one or more of the ducts and alveoli become dilated to form cysts. They are usually seen either during pregnancy or lactation, or as a sequel to the latter, and as such a cyst contains milk which may be altered in various ways, it is called a **galactocele.** A galactocele is due to the obstruction of a main duct by cicatricial tissue in its walls occurring during lactation, and is often caused by a cracked nipple. The cyst wall is lined with epithelium and it is surrounded by a dense layer of fibrous tissue, which increases in thickness the longer the condition persists. The milk which it contains will be altered considerably, and is often cheesy, semi-solid or inspissated. Such a cyst forms a single, round, smooth swelling under the areola and near the nipple, sometimes as big as a tangarine orange, which quite definitely commences after a pregnancy, and steadily increases in size. It fluctuates, and is often soft and elastic, while there is no pain or tenderness and the axillary glands are not enlarged. The longer it lasts the harder and more solid it will be. When lactation ceases the cyst may disappear, but not infrequently it persists and slowly increases in size. In nearly every case, on squeezing the breast, a milky discharge from the nipple will occur. In most cases there is no adherence to the skin or retraction of the nipple, but occasionally, in very old-standing cases, the fibrous wall of the cyst becomes very dense and hard, and then this may cause indrawing of the nipple and puckering of the skin. No swelling should be diagnosed as a galactocele unless it definitely commenced after a pregnancy. If a galactocele becomes large, it will extend to the periphery of the breast and stand out under the skin as a pear-shaped swelling. Occasionally, as the result of external force, the cyst wall will rupture and the milk become extravasated through the breast (*diffuse galactocele*).

Treatment. No treatment need be adopted until lactation is over, but then, if the cyst does not disappear, it should be excised, as otherwise it will give rise to more trouble should another pregnancy occur.

Similar cysts, due to distension of the alveoli when their ducts are blocked, occur in chronic mastitis, and have been described on p. 477.

In young unmarried women isolated cysts are occasionally seen in the breast as a result of irritation of the nipple, either from manipulation or from putting babies to their breasts, the change resulting from an overactivity of the breast tissue. The organ swells and the epithelium proliferates and secretes a thin, watery fluid, which distends the alveoli and gives rise to small, soft cysts. Cystic distension of ducts or alveoli not infrequently occurs in association with various new growths of the breast, such as duct papilloma, duct carcinoma or even scirrhus, owing to the growth pressing upon or obstructing a main duct The form of growth in the breast known as a cystadenoma also gives rise to large cysts in the breast, which are not due to any secondary degeneration (see p. 486).

It must be remembered that in nearly all retention cysts of the breast there will be a certain amount of discharge from the nipple if the organ is pressed or squeezed.

(2) **Involution Cysts.** At or about the menopause the breast undergoes an involution, and at this period cysts containing either a clear, watery fluid or a dark brown, grumous secretion are frequently seen. These are called involution cysts, but it is highly probable that they are really the same as the cysts which occur in chronic mastitis, and that this condition is actually the cause of them. These cysts are multiple and usually very tense. They are seen in the outer and deeper portions of the breast and form smooth, round, uniform swellings, attached to the remainder of the breast tissue, but independent of the skin and pectoral muscle underneath. They will resemble closely a solid tumour, and a diagnosis may be impossible until they are aspirated or incised.

Treatment. If the cyst is a single isolated one it may be removed with a portion of the breast round it, either by a radial incision over it or by a curved incision round the periphery of the lower and outer part of the breast, the organ being then turned up and the cyst excised from its deep surface. In many cases, however, and especially if the cysts are multiple, it is best to remove the whole breast, as any cyst of this kind possibly may be a precancerous condition (see p. 489).

(B) *Interacinous Cysts.* These have no connection with the secreting mechanism of the breast, but arise in the fibrous supporting tissues between the alveoli or in the interalveolar lymphatics.

(1) **Serous Cysts** (Simple Lymphatic Cysts). These are thought to be due to the dilatation of lymph spaces, as occurs in other parts of the body, though it is doubtful if they really exist in the breast and whether such a cyst is not really an unusual form of one of the other varieties described. These cysts are usually multilocular, are lined by a smooth endothelium, and contain a clear fluid, which is sometimes bloodstained and may have cholesterin in it They are surrounded by a thick wall of fibrous tissue and never give rise to intracystic growths or discharge from the nipple. They are quite painless and usually fluctuate distinctly, while sometimes the skin over them becomes thinned and bluish, while they may be even translucent.

Treatment. The best treatment is to remove the cyst completely, but should it occupy more than half the breast, it will be wiser to remove the whole organ.

(2) **Hydatid Cysts.** The breast is one of the situations where hydatid cysts are occasionally seen. Their characteristics, diagnosis and treatment are the same here as elsewhere in the body (see Vol. I., Ch. VI.). Some of the cases thought to be in the breast have very probably commenced in the muscle underneath. They are specially liable to suppurate when in the breast.

(3) **Dermoid Cysts.** Dermoid cysts have been described in the breast. It is, however, difficult to see why or how a cyst of this type should occur in this organ, and it is probable that the recorded cases were really cysts of other types.

(4) Cysts are frequently seen in the breast which are due to hæmorrhage into or degeneration of carcinomata or sarcomata. These will be described on p. 488.

(5) **Sebaceous Cysts.** Large sebaceous glands exist in the areola, and hence these cysts occur commonly in this situation.

(6) **Blood Cysts.** A hæmatoma in the breast following an injury may sometimes give rise to a blood cyst consisting of a small collection of old blood

or serum surrounded by a fibrous wall. The history of an injury with considerable bruising of the mamma, which is followed by a tender, fluctuating swelling, should indicate the diagnosis. Such a cyst should be excised.

NEW GROWTHS OF THE BREAST

General Considerations. The tumours of the breast naturally arrange themselves into the two great classes of simple and malignant growths, and there are certain details in the methods of examining them which are important and which have been referred to on p. 465. In addition, the patient's history is of great importance, both as regards her age, previous and family history, the method in which the lump has appeared and grown, and the length of time for which it has been observed. It must be remembered that a patient's account of how long a swelling has been present in the breast is often notoriously inaccurate, the period usually being greatly underestimated. Her appearance must be noted and inquiry made as to whether pain, local or referred, is present, and whether the pain and swelling vary with the menstrual periods. On examining the tumour, its shape, its consistency, whether uniform or varying, whether smooth or nodular, whether hard or soft, or solid or fluid, must be carefully noted, while attention must be directed carefully to ascertain to what structures it is adherent (see p. 465).

The edge of an intramammary tumour should receive special attention: if the whole border is well defined the tumour is almost certainly simple, while if no definite edge is palpable anywhere, the mass is probably inflammatory. In a malignant tumour the edge is in places palpable and in others fades in definitely into the surrounding tissues.

(A) **Simple Tumours.** Two simple tumours, fibro-adenoma and duct-papilloma, are common in the breast. Lipoma, angioma, fibroma and chondroma have been described, but they are excessively rare, and when they occur their clinical features and treatment are the same as in other parts of the body. A third form of simple tumour is also occasionally seen in the breast, the cyst-adenoma. All innocent growths appear to move freely in the breast tissues.

Fibro-adenoma. Two varieties of fibro-adenoma occur in the breast, the hard and the soft, both containing spaces lined with epithelium which resembles that of the remainder of the breast, and which is sharply limited by its basement membrane. These spaces contain a varying amount of fluid and are surrounded by fibrous tissue, which varies greatly in its thickness, amount and state of development. The glandular spaces have branching tubes lined with epithelium radiating out from them, and in many cases the walls of these spaces are in close apposition, so that very little fluid is present. The distinction between soft and hard fibro-adenomata depends on the relative amount of glandular and fibrous tissue present, while the microscopic section of either of them may resemble a section of chronic mastitis.

(A) **Hard Fibro-adenoma.** In this variety the interstitial fibrous tissue is greatly in excess of the glandular tissues, these latter being very imperfectly developed and sometimes hard to discover, so that the growth may be mistaken for a pure fibroma. Ducts are never present, and the branching alveolar spaces appear to be squeezed more or less flat, while a distinct fibrous capsule is present which is usually incomplete at one spot where the vessels enter the growth. On section such a tumour is greyish or pinkish-white, and has a fibrous or foliated appearance. A little thick fluid may be squeezed out of it on pressure, while on scraping it with a knife it does not feel gritty. This condition is most common in unmarried women under thirty, and is usually in the upper and outer quadrant or at the periphery of the breast. It may occur as a result of a blow or other injury, and gives rise to a rounded or oval, smooth swelling, occasionally nodular, which is firm, tough and elastic and grows very slowly. It is strikingly movable within the breast tissue, and does not appear to be attached either to the remainder of the breast, to the skin, nipple or underlying muscle. The nipple is not retracted, nor are the axillary glands enlarged, while the condition is usually painless, though anæmic or neurotic women will sometimes complain of severe shooting pains, especially during menstruation, both in the breast and referred to that part of the arm and shoulder supplied by the second intercostal nerve.

(B) **Soft Fibro-adenoma.** This condition is very similar, except that the epithelial-lined spaces are present in far greater numbers and the surrounding fibrous tissue is thinner and less developed, while at times evidence of mucoid degeneration is present. The tumour is completely encapsuled, and clinically only differs from the above in that it is softer and grows more rapidly. It sometimes appears at a rather later age, at times growing rapidly from the first, though it is not uncommon for it to start as a slow-growing, hard fibro-adenoma, which, when it has been present for some time, suddenly grows more rapidly and becomes softer. It is soft, elastic and painless, and has the same characteristics of free mobility, and non-involvement of the nipple or axillary glands, as the hard variety. It may reach a large size in time, becoming as big as an orange, and in this case the skin over it will become thin, bluish and translucent.

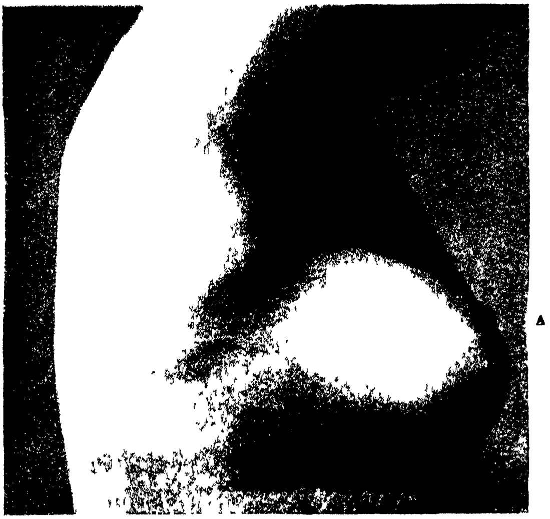


FIG. 167. Lateral view of a small cyst-adenoma of the breast which is just commencing to burst through the skin at A.

There is probably no evidence that fibro-adenomata ever undergo malignant change, but they, however, often do undergo cystic degeneration, in which case they will frequently contain one or more large cysts, these cysts never containing intracystic growths (see p. 486). This condition of cystic degeneration (**cystic fibro-adenoma**) must be distinguished carefully from a cyst-adenoma (see p. 486), a growth which is essentially cystic from the first.

A few cases will be seen in which the proportions of fibrous stroma and glandular tissues bear approximately the same relation to one another as they do in the normal breast, and these have been described as pure adenomata, but they are really only varieties of fibro-adenomata.

Diagnosis. There should be no difficulty in distinguishing these fibro-adenomata from malignant growths, but they may resemble closely patches of chronic mastitis. They have, however, a much more sharply defined outline than chronic mastitis and are met with at an earlier age, *i.e.*, eighteen to twenty-five years, while they are not tender, the axillary glands are not affected, and the important characteristic of free mobility apart from the rest of the breast, and the sensation which they give that they are, as it were, floating about within the breast, should distinguish them at once. This last sign is characteristic of all the non-malignant new growths of the breast. It must be remembered that fibro adenomata (and other new growths) are occasionally surrounded by a small area of chronic mastitis, and if this is so the differential diagnosis becomes impossible.

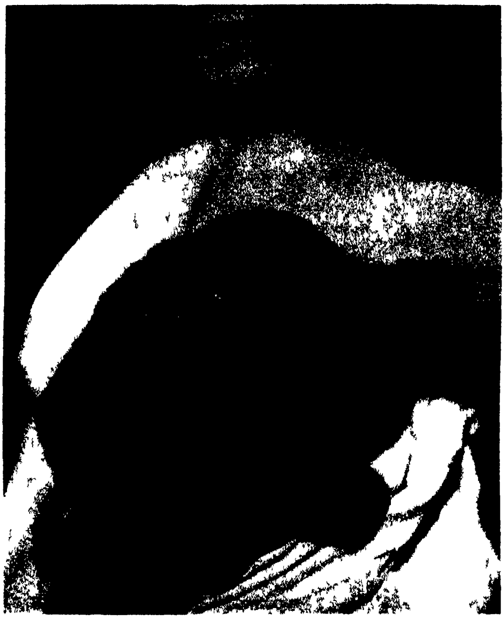


FIG. 168. Very large cyst-adenoma of the breast on the point of fungating. Though it had reached this large size in little over a year, this growth was quite innocent.

Treatment. The treatment of this condition consists in removal of the fibro-adenoma, there being, as a rule, no need to remove the whole breast. If it appears superficial, the growth can be removed easily by making an incision over it, radiating from the nipple; the incision is then deepened until the tumour is reached, and it can then be shelled out by blunt dissection with very little bleeding. If the growth appears to be near the deeper surface of the breast, Galliard Thomas's operation may be performed. In order to do this a curved incision is made along the lower and outer border of the breast, and the whole breast is then turned inwards and upwards as a flap. The deeper surface of the breast thus being exposed, it is incised over the tumour, the growth shelled out, and the breast is then allowed to fall back into place so that the scar will be more or less completely hidden. In all cases great care must be taken to stop all bleeding, and the cavity left in the breast should be drawn together and obliterated with catgut stitches, as otherwise a large hæmatoma may result (see Fig. 183).

Fibroma of the Nipple. A soft fibroma sometimes grows from the nipple or areola, and this usually becomes pedunculated and may hang down a long way. It is symptomless, but is easily removed.

Cyst-adenoma (Cystic Sarcoma, Intracanalicular Adenoma, Adenocele). This is a simple tumour of the breast, somewhat similar to the cyst-adenoma seen in the ovary, and consists in the formation of multiple, large, cystic spaces into the cavity of which grow proliferating intracystic growths, consisting of a core of fibrous tissue, covered with sprouting adenomatous epithelium. These cauliflower-like masses growing inside the cyst often will fill its space almost completely and obliterate its cavity. The epithelium covering them is usually columnar, and the intracystic growths must be regarded as due to an overgrowth of the inter-alveolar mammary tissue, which throws the epithelial wall of the acini into folds and pushes it into the cystic cavity. The growth has a definite capsule, and though it grows rapidly, may become huge and sometimes even will fungate through the skin, it is in no sense malignant. The condition usually occurs in women over the age of forty and gives rise to a soft, rapidly growing swelling, usually irregular or bossy, owing to the formation of multiple cysts, parts of it appearing solid and other portions definitely fluctuating. It is painless, has no enlargement of the axillary glands, and is not adherent to the skin, to the remainder of the breast tissue, or to the muscle underneath. It rapidly becomes very big and prominent, and may then have large blue veins over it, still, however, retaining its mobility, except in so far as this is limited by the actual size of the swelling. As it increases in size the skin over it will become thin and bluish, and finally may give way altogether, allowing the tumour to protrude and fungate as a sprouting, offensive, bleeding mass. When this has occurred it may resemble somewhat closely a fungating malignant growth, but the condition can be distinguished easily by noting that in this case the skin is not adherent to the growth, which gives the appearance of having pushed itself through the skin, that the portion of the skin around the aperture is thinned and undermined, instead of being thickened and infiltrated, as it

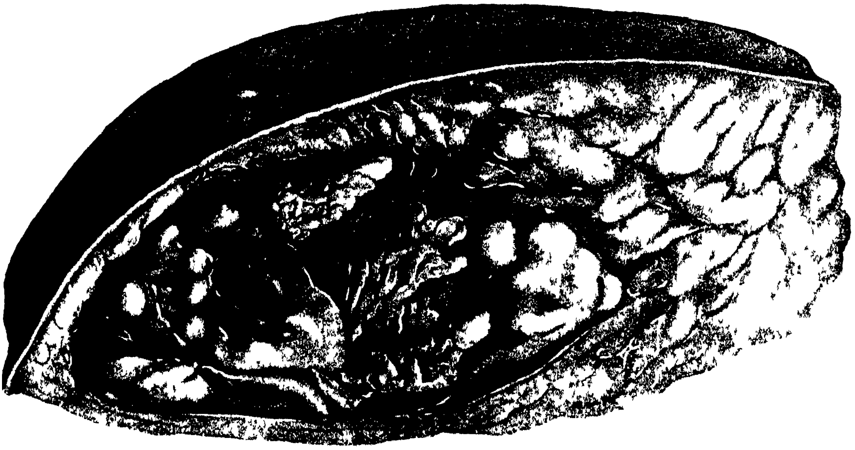


FIG. 169. Specimen of a cyst-adenoma of the breast, showing intracystic growths.

would be if involved in a fungating malignant tumour, while it is usually possible to pass a probe between the growth and the thinned and stretched skin at its side, which is, of course, impossible in a case where a malignant growth has involved and eaten its way through the skin. Metastases and recurrence, if it is properly removed, are unknown.

Treatment. The treatment of this condition is complete removal of the breast. There is no pathological reason why the whole of the breast need be removed, but inasmuch as the tumour is usually much larger than the remainder of the breast tissue, and occupies the greater part of it, it is usually more satisfactory to remove the whole breast with it. There is, of course, no need to remove the axillary glands or the pectoral muscle.

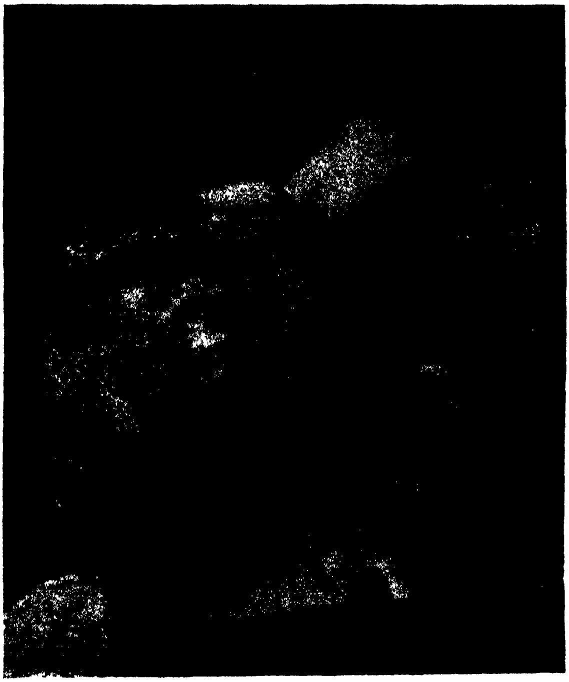


FIG. 170. Sarcoma of right breast, occurring in the same patient shown in Fig. 168, eighteen months after removal of the left breast for the cyst-adenoma there depicted.

Certain surgeons, however, believe that these growths have a tendency to become malignant, and advocate a more radical operation on the lines of that done for cancer of the breast (see p. 502); we do not agree with this procedure.

Duct-Papilloma. This is a soft pedunculated papilloma, growing into a duct or one of the larger milk sinuses, from its wall. The tumour itself is usually quite small, bleeds readily, and may cause obstruction of the duct in which it is, in which case a retention cyst will appear above it, and give rise to a small elastic swelling under the areola. The growth may be single or multiple, and is usually so small as to be impalpable, any swelling that is felt being due to a retention cyst above it.

Clinically the condition is usually seen in multiparæ, and it is thought possibly to be due to prolonged suckling. As a rule no swelling is palpable unless it is accompanied by a retention cyst, and this is usually found close to the nipple; the chief and only symptom of which the patient complains is a clear or, more commonly, bloodstained discharge from the nipple, and this usually appears before any swelling can be felt. There is no enlargement of the axillary glands and no pain, while the nipple, far from being retracted, is sometimes unduly prominent. It must be remembered that a discharge from the nipple is seen in duct-papilloma, duct-carcinoma, and occasionally in tuberculosis of the breast and chronic mastitis. Whenever it occurs it is a strong indication for removal of the breast.

Treatment. The treatment of a duct-papilloma consists first in the application of deep X-rays or the insertion of radium needles around the nipple. This often stops the bleeding and apparently cures the condition. If this fails and the bleeding is persistent, then there should be no hesitation in removing the breast without interfering with the axillary glands or muscles. There is little doubt that in persistent cases this is the safest course, as there is a considerable amount of evidence that a duct-papilloma may become carcinomatous.

(B) **Malignant Tumours.** Two forms of malignant disease are seen in the breast, sarcoma, which is rare, and carcinoma, which is very common.

Sarcoma of the Breast. Approximately only 2 per cent. of all breast tumours are sarcomatous, the disease usually occurring in patients under forty-five, but no age is exempt. It commences in the supporting connective tissue of the organ, the glandular elements of the breast playing no part in the growth, though they may become involved in and surrounded by it, and in many cases it appears to be the result of a blow. Two types of sarcoma occur, the round-celled and the spindle-celled. These vary greatly in malignancy, the **round-celled sarcoma** having the same appearance here as it does all over the body, being highly malignant, and soon breaking through any thin capsule which it may have. It rapidly infiltrates the whole breast and often the other breast, and soon gives rise to secondary growths in the axillary glands and elsewhere all over the body; it frequently undergoes cystic or hæmorrhagic degeneration. Myxomatous degeneration also is not uncommon, especially in the very rapidly growing types. The **spindle-celled** type, on the other hand, is much less malignant, and really more resembles a fibro-sarcoma, or recurrent fibroid tumour of Paget (see Vol. I., Ch. XIII.). This form grows more slowly and is harder; it does not as a rule involve the axillary glands or cause metastases elsewhere, but it frequently recurs locally after complete removal, recurrence being more and more rapid each time, while it gradually tends to become more vascular, more malignant and tender.

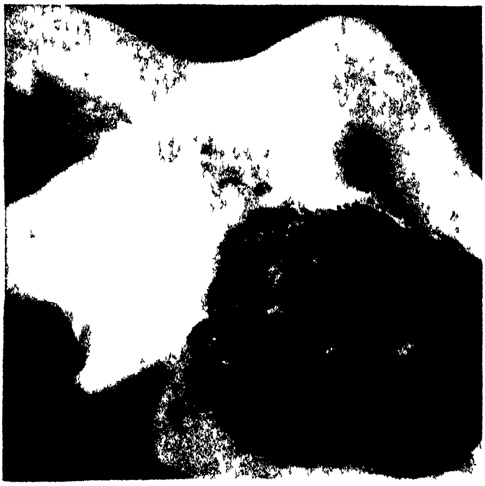


FIG. 171. Fungating melanotic sarcoma of the left breast in a woman of thirty-six. This had been present fourteen months.

Clinically a sarcoma appears as a soft, rapidly growing, smooth, painless swelling, which is fixed to the remainder of the breast tissue and soon infiltrates the whole organ, while it will not be long before it is adherent to the skin and to the muscles underneath. The axillary glands are soon involved, becoming enlarged, firm and adherent, while the skin over the growth has large blue veins in it and ultimately becomes stretched, dusky in colour and gives way. The tumour later on may become bossy, and a characteristic feature is its irregularity, parts of it being hard, parts soft, and parts fluctuating. Rise of temperature is not uncommon, while it will be found that if a pregnancy occurs the rapidity of the growth is enormously increased, and in these cases the condition has been mistaken for an abscess. In common with all other sarcomata, rapid dissemination to the lungs, liver and brain will occur. There are no signs of fibrosis, as shown by retraction of the nipple or dimpling of the skin. The spindle-celled form, on the other hand, is considerably harder and slower in its growth, neither the skin, the remainder of the breast tissue, nor the axillary glands being involved for a comparatively long time. In its very early stages it will resemble somewhat an adenoma, except that it has not got the distinguishing feature of mobility apart from the remainder of the breast tissue. A sarcoma does not, as a rule, exhibit so marked a tendency to pick out the lymphatic glands as does a carcinoma, but in the breast the axillary glands soon become invaded, on account of the rapid involvement of the skin over the growth.

Secondary sarcoma is occasionally seen in the breast—sometimes appearing simultaneously on the two sides.

Treatment. The treatment consists in removing the breast, the axillary glands and the pectoral muscles, in the same way as for a carcinoma (see p. 502), with subsequent irradiation of the area, but in the round-celled type of sarcoma the prognosis is very unfavourable. Radium may be used on inoperable growths with a chance of success, while some surgeons advocate that it should be put into the wound after operation in the hope of preventing recurrence. As nearly every case of sarcoma of the mamma sooner or later will fungate and produce a foul, stinking, sprouting mass, it is nearly always wise to remove the primary growth, however poor the chances of a permanent cure may seem to be.

CARCINOMA OF THE BREAST

It will be found that nearly three-quarters of all tumours of the breast are carcinomatous, the only other organ of the body which is as liable to cancer as the breast being the uterus. This disease commences in the majority of cases in the epithelium lining the secreting alveoli, but in a few cases it appears to be the epithelium of the larger ducts that is the starting point, and in either case the tumour may be said roughly to consist of masses of incompletely formed epithelial cells surrounded by a very varying amount of fibrous tissue, this being usually well formed. In the former case, where the growth commences in the secreting acini, the cancerous epithelium is spheroidal in nature (spheroidal carcinoma, carcinoma simplex, or glandular carcinoma), but in the latter case, where the origin of the disease appears to lie in the larger ducts, the epithelium is usually columnar. The condition is usually met with about middle age, though it will be seen not infrequently before this, cases having been recorded at twenty and at ninety, and, unfortunately, the younger the patient is, the more virulent the growth appears to be. The left breast is more commonly affected than the right, and the growth is rather more common in the upper and outer quadrant of the breast than elsewhere, the other quadrants being involved in order of frequency as follows—lower and outer, upper and inner, and lower and inner. There appears to be no difference in its incidence in multiparæ or in nulliparæ, nor does the question of whether the breast has been used for suckling make any difference. The question of a hereditary predisposition to this disease is continually being raised, but there is probably no evidence of any such tendency, although occasionally striking family histories will be encountered. In some cases there appears to be a reasonable suspicion that a blow has started the condition, and it is quite possible that the continual irritation of high and badly-fitting corsets is a predisposing factor; there is also little doubt that there exist several predisposing diseases, which almost may be regarded as precancerous. Chronic mastitis is one of these, as also is the formation of cysts with proliferating epithelial walls. Paget's eczema of the nipple (see p. 469) hardly can be regarded as a precursor of the condition, but is undoubtedly an accompaniment. In a few cases it will be found that the patient has previously suffered from other disease of the breast, such as a mammary abscess or fibro-adenoma, and in a breast which has been much scarred and puckered as the result of previous mammary abscesses which have probably been incised, it may be very difficult to settle whether an early carcinoma is present or not. Occasionally a bilateral carcinoma of the mamma is seen, while the disease sometimes commences in accessory mammæ and in the axillary tail. It must be remembered that the breast is an organ which is continually throughout life undergoing sudden and extreme changes in function and structure—birth, puberty, menstruation, pregnancy, lactation, and the menopause all affecting it—and these changes may well render its extensive epithelium particularly liable to the development of carcinoma.

The Spread of Carcinoma of the Breast. As we shall see later, there are many different varieties of cancer of the breast, and this disease spreads from the breast to other parts of the body in the same ways as do carcinomatous growths in general (see Vol. I., Ch. VIII.). All the different methods by which carcinoma can extend are illustrated in this situation, but there is little doubt that a great part is played by embolism rather than by permeation of the lymphatic vessels, in which the carcinoma cells grow forward as a solid column inside the lymphatic tubes, radiating centrifugally in all directions from the primary growth, quite independently of the direction of lymph flow. In this way the growth rapidly involves the axillary glands, and may find its way into the mediastinum, into the abdomen and liver, via the epigastrium, and to the bones and various structures at a distance, while the permeation of lymphatic vessels which run up from the fascial lymphatics into the skin will account for the various ways in which the skin may become involved (see p. 495). This permeation of the lymphatic vessels is followed by a reactionary fibrosis, the vessels becoming converted into solid strands of contracting fibrous tissue, and this partly accounts for the extensive puckering that may occur round some growths. In some cases direct infiltration accounts for the spread into the muscles and chest wall, while it is possible in other cases that both lymphatic emboli and blood-stream emboli of cancer cells may play a part. Once the growth has invaded the peritoneum via the epigastrium, the transcœlomic transference of carcinoma cells will play a part and the growth may then become diffused by this method throughout the peritoneum. Thus it will be seen that the nearer the primary growth is to the mediastinum or epigastrium, the more rapidly may secondary deposits within the chest or abdomen occur, and thus the prognosis of those growths which occur in the inner half of the breast is distinctly worse than the prognosis of those in the outer half of the breast. Secondary deposits in the bones are common, those bones near the breast (ribs, spine, sternum) being first involved, and later more distant bones. The bony deposits are not found near the entrance of their nutrient vessels, and Handley cites this as direct evidence that such bony involvement is due to growth along the lymphatic vessels and not to embolism by the blood stream as is held by most authorities. It will be seen from this that inasmuch as most of the lymphatic vessels draining the breast run in the fatty fascia under the skin, this is the dangerous layer in which the spreading edge of the column of cells growing along the lymphatics has grown farthest, and that this fascia should be very freely removed at operation, throughout a roughly circular area, with its centre at the primary growth.

Carcinoma of the male breast is not common, and it is found that about 1 per cent. of all breast cancers occur in males. It usually occurs after the age of fifty, though again cases will occasionally be seen under thirty; it appears to grow rather more slowly than in the female, but to ulcerate through the skin rather sooner, these two features doubtless being due to the fact that the breast tissue is so much less in amount and less vascular in the male than in the female. Involvement of the axillary glands and metastases elsewhere in the body follow the same course as in the woman, but inasmuch as the condition is not usually suspected or diagnosed as early, the male cases are not usually seen until they are advanced, and the liability to recurrence after operation will therefore be greater.

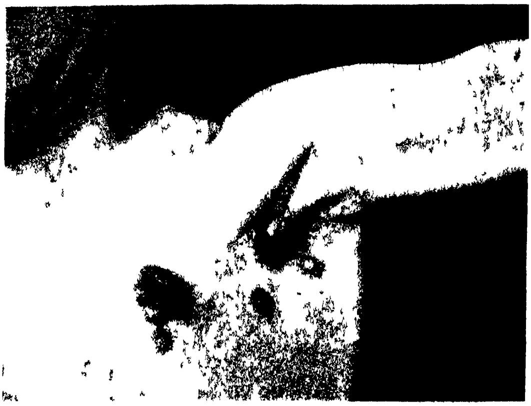


FIG. 172. Carcinoma of the male breast, showing fungation of the primary growth, fungation of the axillary glands and several nodules in the skin round.

(1) **Spheroidal-celled Carcinoma.** This group includes the great majority of all cases of carcinoma of the breast, and it is subdivided into various types, according to the relative amounts of cancerous epithelial cells and of firm fibrous tissue present. We may regard the fibrous tissue which is formed around the cancerous cells as being in a measure protective and representing the effort of the body to shut off the malignant epithelial cells and to strangle them by the pressure of a surrounding fibrous stroma, and the malignancy of such a growth may be regarded therefore as inversely proportionate to the

amount of fibrous tissue it contains. It must be remembered, however, that the various types of spheroidal carcinoma of the breast, as gauged by their fibrosis, pass insensibly one into another and that many intermediate varieties will be seen, forming a complete series from the hardest and most fibrous type of scirrhus down to the most soft, acute, and rapid encephaloid cancer (see p. 497).

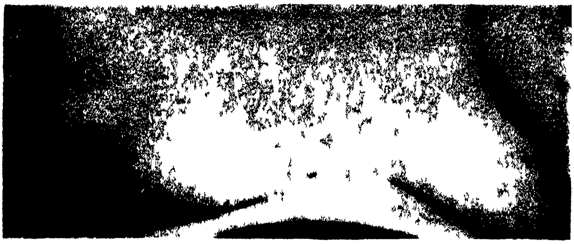


FIG. 173. Scirrhus of the right breast, showing marked retraction and elevation of the nipple

Scirrhous Carcinoma. This is the commonest variety found in the breast, and here the fibrous tissue elements are prominent, there being only a comparatively small number of isolated groups of cancerous atypical spheroidal epithelial cells. These cells are, moreover, scattered about throughout the fibrous tissue indiscriminately, do not as a rule present any definite arrangement into alveoli, and are provided with no limiting basement membrane. At the central parts of the growth the combined efforts of the pressure of the fibrous tissue and of insufficient blood supply often will cause the epithelial cells to undergo either a fatty or colloid degeneration, while at the periphery of the tumour the reverse condition holds good, the fibrosis is less marked and the cancer cells are more numerous and better formed. Where the cancer is encroaching upon normal breast tissue these epithelial cells can

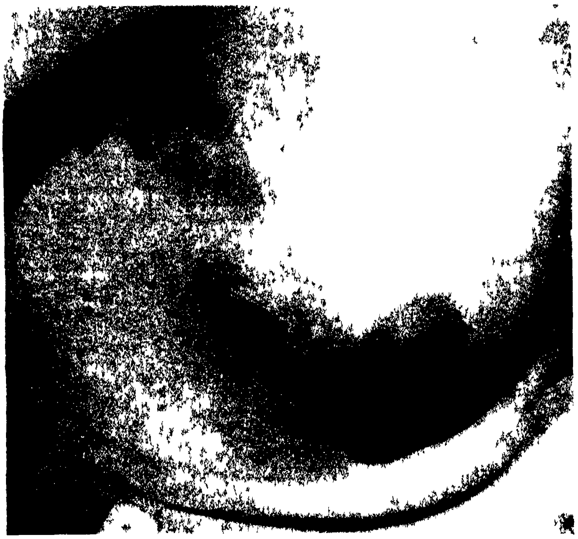


FIG. 174. Carcinoma of the axillary tail of the right breast.

be seen bursting through the walls of the alveoli and rapidly invading the tissues outside, so that the interacinous septa and lymphatic vessels are soon involved, while around the tumour the breast will show a certain amount of reactive inflammation, with hyperæmia and infiltration with round cells. On cutting such a tumour across it gives a creaking, crepitating feeling to the knife, and on section it has a concave surface and a greyish-white translucent appearance, with a gritty feel on scraping it with the knife blade, while a watery juice can be pressed out of it, the whole appearance being rather like that of an unripe pear. Small yellow spots due to fatty degeneration will be seen in it, and there may be hæmorrhages or cysts, while the central mass of the tumour often will be found to be sloughing and undergoing necrosis. Strands of growth and fibrous tissue will often be seen radiating through the breast in all directions, while if the cancer is an advanced one the skin over it will be involved and possibly ulcerated, the growth may have involved the pectoral muscle underneath, and there may be a continuous streak of carcinomatous tissue running right up to the nearest axillary glands.

FIG. 175. Ulcerating carcinoma of the breast, showing typical malignant ulcer, nodules from lymphatic permeation, skin retraction and elevation of the nipple.

Clinical Features. This type of growth is most commonly seen between the ages of thirty-five and sixty, and it is not the type that is likely to occur in younger or older patients. It may occur anywhere in the breast and may rarely be multiple, but is most common in the upper and outer quadrant, and commences as a hard, localised mass, which is quite painless and is often noticed accidentally. It is stony hard, firmly attached to the rest of the breast tissue and usually nodular and irregular to the feel. Such a growth usually becomes adherent to the skin over it rapidly, while in many cases, especially in the very fibrous growths, a definite dimple or pucker will be seen in the skin. The nipple frequently becomes gradually drawn in and retratced, while if the growth is in the upper half of the breast, the whole breast and nipple may be drawn upwards, and the nipple will then come to lie at a higher level than that of the other side. The swelling formed by the growth stands out very prominently; it in no sense seems to disappear when pressed upon with the flat of the hand, and even may appear harder and more obvious when this method of examination is employed. As the growth advances it frequently tends to infiltrate the whole breast, with the result that the entire organ may become smaller and shrunken and puckered, and sometimes it will be found that it is difficult to persuade patients that there can be a growth in the breast when the breast is smaller than the one on the other side. In the later stages the growth will become adherent to the pectoral muscle or the fascia over it, and this can be demonstrated by the test described on p. 465. A scirrhus is very rarely of a large size, and though usually remarkably painless, rare cases will be seen which are quite painful and tender, and in such cases the pain may radiate through the shoulder and down the arm. If allowed to progress long enough it ultimately will become fixed to the underlying ribs and chest wall.

It must be remembered, above all, that any of the above signs may be absent, that in some cases we must be prepared to make the diagnosis upon the presence of only one of them, and that such features as adherence to the pectoral muscle, marked enlargement of the axillary glands or firm adhesion to the skin are signs that the growth is advanced, and we should hope to diagnose the condition before this stage is reached. The most important feature of all is the stony hardness and nodularity of the growth, but even this may not be discernible in the case of a big and fat breast. Whenever, therefore, there is the least doubt about the diagnosis, an exploratory operation must be undertaken.

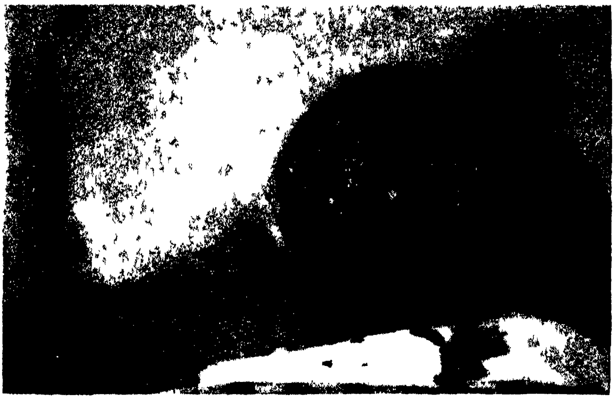


FIG. 176. Extensive fungating carcinoma of the left breast.

The axillary glands will soon become enlarged and stony hard, and they in their turn will become fused together and adherent to the surrounding structures.

The pectoral glands lying under the pectoralis major are usually enlarged first, while soon after these the central axillary, the subscapular and subclavian groups also will be invaded in this order In time the supraclavicular glands will also become hard and enlarged, while in the end the mediastinal glands, the lungs and pleuræ and the liver and peritoneum all will become carcinomatous. The length of time taken before the thorax or abdomen is invaded is very variable and it sometimes occurs quite early in the disease (see p. 490), while it is not unusual in the case of growths in the inner half of the breast to find that the opposite breast is quite early involved and the opposite axillary glands may be invaded too, this doubtless occurring by permeation of the lymphatic vessels which cross the midline of the sternum. In the course of time the enlarged axillary glands will press upon important nerve trunks and cause paralysis and severe pain, and also they may compress the axillary vein and give rise to venous œdema of the arm and hand; but a more common condition is for them to obstruct the lymph flow, and this, together with the obstruction of the small lymphatic vessels of the chest and shoulder caused by their diffuse permeation with carcinoma cells, gives rise to a solid œdema of the hand and arm which will cause a great deal of swelling and pain and a condition of pseudo-elephantiasis.

It must be noted that it is quite likely that small carcinomatous axillary glands will be impalpable and that if no glands can be felt in the axilla it does not at all follow that the lymphatic glands are not invaded. It is also important to compare the axillary glands of the two sides, as many persons have palpable glands always present; and if, therefore, glands of approximately the same size and consistence can be felt in both axillæ, they are probably not malignant. When carcinoma invades lymphatic glands, the cells enter the gland at its hilum and are first deposited here on the surface of the gland; it then often happens that the cells spread out of the gland and invade the surrounding tissues, producing fixity some time before any extensive infiltration of the gland itself has occurred.

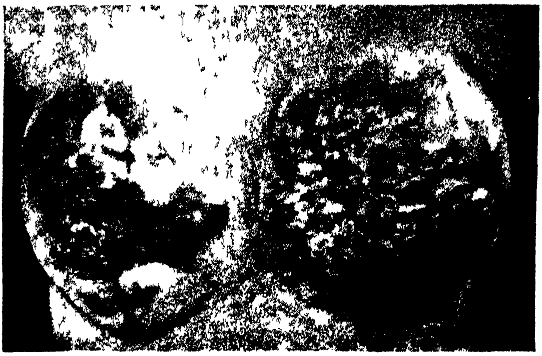


FIG. 177. Bilateral carcinoma of the breast, showing fungation on the right side and carcinoma en cuirasse on the left side.

Sooner or later in all carcinomata of the breast *the skin will become involved*, and this may occur in several ways :—

(*a*) We have already mentioned the adherence, dimpling and puckering which is seen.

(*b*) A later stage of this condition is caused by the growth extending outwards along the suspensory ligaments of Cooper and invading the skin itself, causing it to become firm, hard and red or dusky in colour. Soon after this occurs the skin will give way and an ulcer will form, which may become very large. This form of carcinomatous ulcer is often deep and sharply cut, with its surrounding edge hard and raised (**crateriform ulcer**). Its base is covered with firm red growth, and there may be a profuse and offensive watery discharge. In other cases, after ulceration of the skin has occurred, the tumour substance will fungate through and ultimately will give rise to a large, sprouting purple or green stinking mass. The skin surrounding such an ulceration for some little distance will, of course, be invaded by and densely adherent to the growth underneath. It is usually the fibrous, scirrhous type of growth which gives rise to the crateriform ulcer, while the softer, rapid encephaloid growth (see p 497) is more likely to fungate and sprout out.

When ulceration of the skin has occurred, the involvement of the lymphatic glands becomes more marked, and they may change from being hard and painless, so that they become softer and tender as a result of the superadded septic infection.

(*c*) A less common condition is one in which an extensive permeation of the lymphatic vessels immediately under the skin, and draining the skin over the breast, occurs. This permeation blocks the lymphatics completely and interferes so much with the cutaneous lymphatic drainage that a condition of solid lymphatic œdema of the skin over the breast is set up. This condition is known as **peau d'orange skin,** as it closely resembles the skin of an orange, being thicker and tougher than usual, while the openings of the sebaceous glands are enlarged and present all over it in the form of shallow pits, closely resembling pig-skin. It is evidence that the growth is advanced and that extensive lymphatic permeation is occurring.

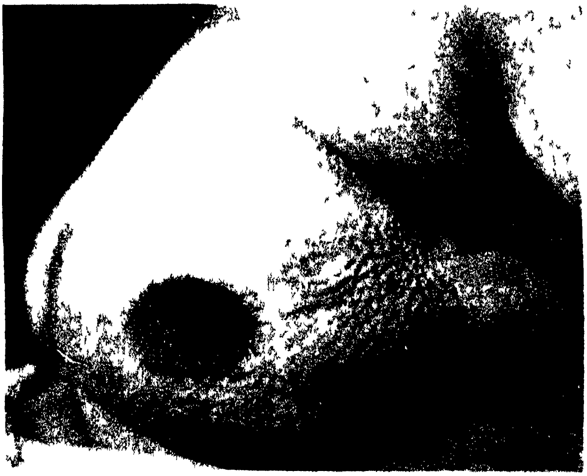


FIG. 178. Spheroidal carcinoma of the breast, showing marked "peau d'orange" skin and retraction of the nipple.

(*d*) In some instances the carcinoma cells exhibit a peculiar tendency to spread far and wide in the skin without such extensive involvement of the deeper structures, and when this occurs it may be regarded as a more advanced stage of the above condition, and one which soon may follow upon it, the cancer cells actually invading and diffusely infiltrating the skin. Little nodular masses of growth close to each other develop in the skin and soon fuse together, so that the skin for many inches round becomes hard, leathery, brawny and infiltrated, while its colour becomes red or dusky; not infrequently the sebaceous glands pour out an excessive secretion, so that the surface of the skin becomes covered with crusts and scabs without actually being ulcerated. This condition is known as **cancer en cuirasse,** and may spread far and wide, even on to the shoulder and the back; though in some cases it appears to be remarkably chronic and to last even for a year or two, it is a quite hopeless condition. On the other hand, violently acute forms of this condition are sometimes seen, where the skin is red, hot and infiltrated and may resemble an acute eczema. The process will then spread rapidly and extensively and soon terminate the scene.

(*e*) It not infrequently happens that while the skin near the growth appears to be remarkably free from any invasion, one or two isolated carcinomatous nodules will appear in it at some little distance from the primary growth. This is, of course, evidence that the growing tip of the column of cells permeating the lymphatic vessels has reached at least as far as this nodule, probably farther, and that the microscopic extension of the growth is therefore already extensive.

Metastatic growths will appear in various parts of the body at very varying rates of rapidity, the liver, the lungs, the peritoneum, and the bones being the most common sites. The bones specially liable to be involved are the ribs, sternum, upper end of the femur, vertebræ and humerus, and the first sign of such a deposit often will be a pathological fracture of the bone. Secondary growths in the vertebræ are comparatively common and always should be looked for. For their signs and symptoms, see p. 135.

A few rare cases have been described in which one or sometimes very many of the bones have been diffusely permeated with carcinomatous tissue, so that, without actually fracturing, they soften and bend (**carcinomatous osteomalacia**) (see Vol. I., Fig. 308). In this way the patient may become bent and deformed to a remarkable extent.

FIG. 179. Atrophic scirrhus of the breast, showing elevation of the nipple and puckering of the skin round.

In the later stages of the disease, unlike the early stages, there is severe pain due to both the primary and the secondary growths. The patient becomes emaciated, feeble, and has a dry, or sallow, yellow skin, there being a marked cancerous cachexia. There are certain to be extensive ulcerated surfaces from which septic absorption and toxæmia will occur, and the arm will frequently become greatly swollen and brawny as a result of lymphatic œdema following on obstruction of the lymphatic vessels (see p. 505). Death ensues on an average in an untreated case about two or three years after the lump is first noticed, and is due either to pain and exhaustion, septic absorption, or the effect of visceral secondary deposits.

Acute Encephaloid Carcinoma (Medullary Cancer). In this form of spheroidal carcinoma of the breast the epithelial cells greatly predominate, while the fibrous stroma is scanty, ill-formed, soft and vascular. On section, the growth to the naked eye has a homogeneous, brain-like appearance rather similar to a sarcoma, while on microscopic examination it will be seen to consist of large areas of closely packed and poorly developed spheroidal epithelial cells, having no controlling basement membrane and nowhere exhibiting any tendency to form alveoli. These large cellular areas are, at scattered intervals, surrounded by a poorly developed fibrous tissue. The disease is not common, and usually occurs in women under the age of thirty-five, in whom it gives rise to a soft, rapidly-growing swelling in the breast, the whole organ being soon diffusely infiltrated and adherent to the surrounding structures. Secondary deposits in the axillary glands and metastatic deposits in other parts of the body, especially in the chest, occur much more rapidly than in a scirrhus, the disease usually proving fatal from these metastases before it has been present many months. It causes no shrinking of the breast, retraction of the nipple or dimpling of the skin, but the breast rapidly becomes enlarged and the skin is soon invaded, thickened and discoloured, outlying nodules and carcinoma en cuirasse occurring very early. Ulceration through the skin will soon set in, and in this case a green or purple foul sprouting mass grows out through the opening, the appearance being quite different from that of the crateriform ulcer which results from the ulceration of a scirrhus (see p. 495). Cystic degeneration and hæmorrhages often occur in this form of growth and cause areas of fluctuation to appear. The prognosis is very bad, and it is doubtful if a radical operation offers any prospect of a permanent cure (see p 505).

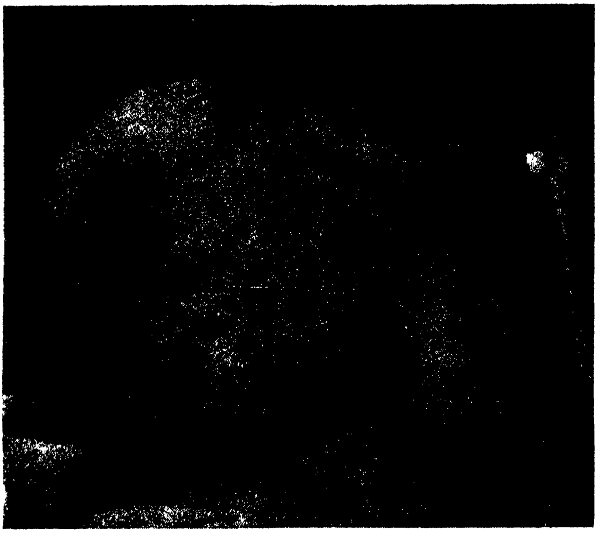
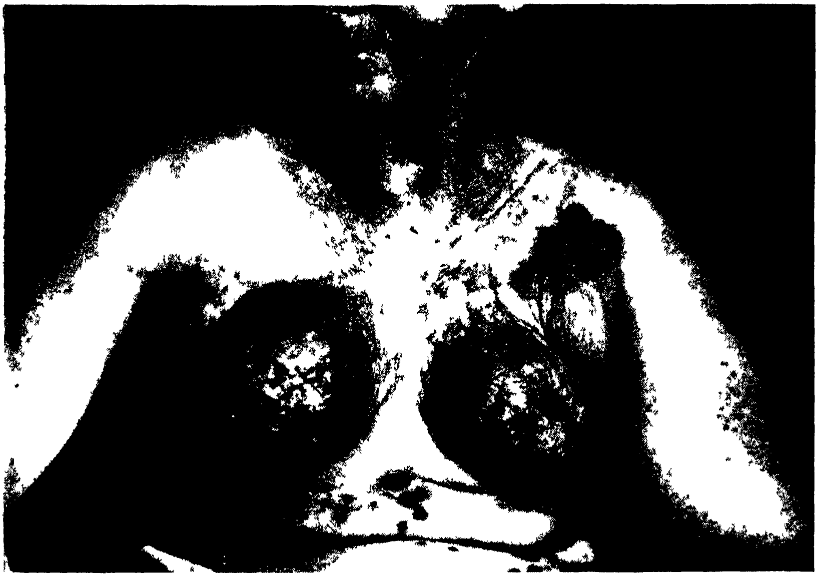


FIG. 180. Atrophic scirrhus, showing puckering of the skin and indrawing of the nipple in a patient of seventy.

Lactation Carcinoma. This is an even more acute and virulent form of growth than the last, and it may be defined as an acute encephaloid carcinoma occurring in a lactating breast, the patient naturally being usually a young woman. In this condition the pathological appearance of the growth is the same as in the last, though it is even more vascular and the activity and vascularity of the lactating breast appear to make its malignancy greater and its growth more rapid. Within a very short time of its appearance the whole breast is infiltrated and the skin over it is red, purple or œdematous, and has dilated veins in it. The whole breast is hot, and there is frequently some general rise of temperature, so that when the condition occurs it is not

PLATE III



Carcinoma of both breasts (cancer en cuirasse) with extensive skin involvement and lymphatic oedema of the left arm Below are X ray films of this patient's humerus

Secondary carcinomatous deposits in the humerus, showing (A) pathological fracture, (B) union occurring.

infrequently mistaken for a mammary abscess, occurring during lactation. It can, however, usually be distinguished by its painlessness, the fact that there are no rigors, malaise or fluctuation, and that the axillary glands are painless and fixed. The condition is hopeless, and any operation performed must be simply a palliative one.

Atrophic Scirrhus. This variety of spheroidal carcinoma of the breast is exactly opposite to the two preceding forms, for in this case there is evidence that the body has made a very strong attempt at a natural cure by strangling the malignant cells with newly-formed fibrous tissue. On section such a growth appears to consist almost entirely of thick and well-formed fibrous tissue, having scattered throughout it a few small isolated areas of ill-developed spheroidal epithelial cells, these cells, however, having no definite arrangement and being limited by no basement membrane. In some cases it will be quite difficult to discover any of these epithelial cell groups at all. The condition usually occurs in thin patients over sixty, and is sometimes found to arise at the age of seventy-five or even eighty. It gives rise to a small, very localised swelling in the breast, which is exceedingly hard and grows very slowly, and in many cases the patient will live for fifteen or twenty years, and may even die of some other intercurrent condition. In time the swelling becomes adherent to the skin and to the pectoral muscle underneath, while the breast is often puckered and contracted and the nipple indrawn. Cases are sometimes seen in the axillary tail of the breast, where the only sign of the disease is a small puckered indentation of the skin with a very slight amount of induration round it. In the more diffuse form, where the whole breast is involved, the organ in time becomes converted into a small, hard swelling, with puckered skin over it and closely adherent to the chest wall. As a rule, the axillary glands do not become involved for some years, but in the end they usually become enlarged, and ultimately dissemination throughout the body may occur in the usual way. Very occasionally a complete spontaneous cure may result.

Colloid Carcinoma. It is rare for colloid degeneration to occur in growths in the breast, but cases will occasionally be seen in which this happens, and where the carcinoma cells degenerate and form a substance which may be regarded as colloid or mucin. When this occurs the swelling becomes bigger and softer, and may contain bosses on it, which feel cystic owing to the mucin they contain. This colloid form of carcinoma grows more slowly and its malignancy is less, so that the appearance of enlargement of the axillary glands and metastases elsewhere is delayed. The prognosis is particularly favourable after operation.

(2) **Columnar-celled Carcinoma.** The only form of columnar carcinoma which occurs in the breast is thought to arise from the epithelium of the walls of the larger ducts, and it is known therefore as **duct-carcinoma.** It is a rare form of the disease, and its pathological nature is not known for certain, but it is probably closely related to a duct-papilloma (see p. 487). On microscopic section it will be found usually to consist of one or more papilliferous nodules growing within the lumen of a large dilated duct from the wall of the duct and covered with a columnar epithelium, which exhibits a malignant tendency to break through its basement membrane and invade the surrounding structures; often it will implant itself upon neighbouring portions of the ducts or alveoli. Clinically the condition is not very malignant, and gives rise to a small swelling within the breast, not far from and attached to the nipple. It grows slowly and sooner or later becomes attached to the skin,

which ultimately will become red and dusky, and may even give way and ulcerate. The swelling is closely attached to the remainder of the breast tissue, does not as a rule give rise to retraction of the nipple, although attached to it, nor does it cause puckering of the breast or early enlargement of the axillary glands, but a very constant feature is the presence of a blood-stained discharge from the nipple. The condition is sometimes associated with an ordinary scirrhus elsewhere in the breast and exhibits a great tendency to form small cysts, doubtless due to the way in which the ducts become obstructed.

Another form of columnar carcinoma of the breast, of low malignancy, and which probably also arises from the main ducts, is the so-called **adeno-carcinoma** of Halstead. Here the growth consists of a fibrous stroma, which surrounds and contains round or cylindrical tubules lined with several layers of columnar epithelium, here and there proliferated and thrown into folds, while the epithelial cells will be found in places to be invading the fibrous stroma. Clinically it behaves in the same way as does the ordinary duct-carcinoma, being comparatively soft and slow-growing; it is sometimes more or less encapsuled and is always of relatively good prognosis. Axillary infection and metastatic deposits are long delayed, but it appears to have a special tendency to fungate through the skin. In other instances it has drawn out a process of the skin covering it, so that it becomes pedunculated and hangs down below the breast.

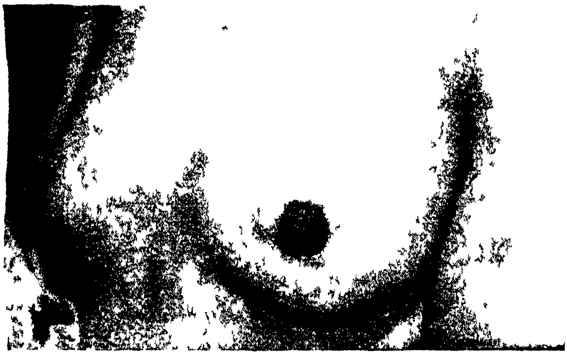


FIG. 181. Duct-carcinoma of the breast (columnar-celled) just commencing to ulcerate.

The duration of these various types of carcinoma varies considerably, and whereas the ordinary scirrhus, if left untreated, probably will end the patient's life within from two to three years, a patient with an encephaloid carcinoma is not likely to live more than a year, while in the case of the lactation variety six months is the more probable duration. The atrophic scirrhus often will last indefinitely, and, as it occurs in elderly people, in many instances their life is ended by some other independent condition. A duct-carcinoma is also of a low grade of malignancy, and it is unlikely that the patient will show any signs of metastases for three or four years.

Differential Diagnosis. In a well-marked case, where the growth is hard, nodular, fixed to the skin, and where the axillary glands are big, hard and fixed, the diagnosis is easy, but this must be regarded as too late a stage in which to make the diagnosis, and it is the early case which presents the most difficulty and which most repays an accurate diagnosis.

Inasmuch as a cancerous growth in the breast is always closely adherent to and incorporated with the rest of the breast tissue, there should be no difficulty in diagnosing it from any of the innocent new growths of the breast, such as a fibro-adenoma or a cyst-adenoma, for the great characteristic of these innocent tumours is that they can be felt to move about independently of the rest of the breast (see p. 484); moreover, these simple growths are softer, less nodular, and more sharply defined than a carcinoma. The greatest difficulty, therefore, in differential diagnosis will arise in connection with inflammatory swellings, such as chronic lobar mastitis, tuberculous mastitis, cysts, or chronic abscess.

The distinction between cysts and patches of chronic mastitis and carcinomatous growths has already been described on p. 477, and the most important points to be observed are the nodularity, the hardness, and the definite outline of the mass and any slight attachment to the skin, or minor degree of indrawing of the nipple. *It is a safe rule to regard any hard ill-defined lump in the breast of a woman of over thirty-five as being cancerous until proved to be otherwise, and in all doubtful cases to insist on early exploration.*

On examining a section of a breast tumour with the naked eye, we must remember that the fibro-adenoma is pinkish-grey, homogeneous and not gritty; a mastitic swelling consists of a mass of well-formed fibrous tissue, containing cysts with clear or dark-coloured fluid in them, while a scirrhus is concave on section, whitish-grey, gritty, with yellow spots on it, and a juice may be scraped or squeezed out of it, like an unripe pear. There is no capsule, and the fibrous strands ramify in the breast and surrounding fat in all directions. The softer forms of growth are succulent and flabby like brain tissue, and in no way resemble any of the other conditions.

Treatment. The only treatment that presents a reasonable possibility of a permanent cure consists in complete and radical removal of the breast and all adjacent structures to which the growth may have spread, and the modern operation for achieving this is based upon strict pathological principles; while many surgeons nowadays supplement the removal by a thorough irradiation of the chest axilla and neck by deep X-rays or radium in from six weeks to two months after the operation. This certainly seems to diminish the tendency to local recurrence. Cases will be seen, unfortunately not infrequently, in which even the modern extensive operation offers no real chance of a permanent cure, and they are then said to be, from this point of view, inoperable, although it is quite likely that limited and palliative operations even then may save the patient much suffering and possibly prolong her life. We must consider, therefore, briefly the indications which render a carcinoma of the breast inoperable from the point of view of a radical cure. Apart from general or constitutional diseases, the presence of visceral deposits will negative entirely such a procedure, and an examination must be made to ensure that these are not present, their favourite sites being the spine and other bones, the lungs and the liver. Absolute fixity of the growth to the ribs and chest wall also contra-indicates operation, but fixity to the pectoral muscle, or the presence of enlarged glands in the axilla, provided these are not themselves fixed to important structures, is no bar to a radical operation, though it undoubtedly renders the prognosis as to permanent cure worse. The presence of enlarged glands in the supraclavicular fossa also does not render the case inoperable, as they can be removed at the same operation, but if there is evidence of malignant disease in the glands of the supraclavicular fossa or axilla of the opposite side, no radical operation should be performed. The condition of the skin overlying the breast is of extreme importance in this connection. Adherence to the skin or ulceration or fungation through the skin do not in themselves render the case inoperable, nor does peau d'orange skin, although this feature renders the prognosis much more grave, but the condition known as cancer en cuirasse, indicating as it does that there is a widespread infiltration of the skin with carcinoma cells, is in the opinion of most surgeons a complete bar to the performance of any radical operation. In addition, the presence of isolated nodules in the skin, more than an inch or so away from the growth, shows that the subcutaneous lymphatic plexus is widely permeated, and that the chances of a complete cure are nil. Œdema of the arm and hand, and pain due to pressure on the brachial plexus, render it inoperable, while in addition it is doubtful if it is ever worth while performing a radical operation in the case of a lactation carcinoma, or a rapidly growing encephaloid growth in a comparatively young subject. An atrophic scirrhus, on the other hand, is sometimes not removed, as it is held by some surgeons that it is not likely to end the patient's life or do her harm, and that, if operated on, the cells may be stimulated to a quicker growth and that a rapid recurrence may occur. This is a view, however, with which we do not agree, and we hold that an atrophic scirrhus should be removed on the ordinary lines, though the operation need not be so extensive as in more malignant cases. The disease is occasionally seen in both breasts, and, provided they are both in an operable condition, there is no reason why they should not both be removed, either at the same time or, better, with an interval between the two operations, though the prognosis will of course be more grave.

The prognosis in rapidly growing tumours or in young patients is unfavourable, but since the modern operation has been performed, some surgeons have been able to report from 50 to 60 per cent. of cases as free from recurrence at the end of three years, according to whether the axillary glands were found to be enlarged at operation or not; while with subsequent deep X-ray treatment, carried out six weeks after operation, 75 per cent. of cases have been cured at the end of six years. There is no doubt that this is too short a period in which to claim a cure, for recurrences are sometimes seen as late as eight, ten or fifteen years afterwards. Whether these cases really should be regarded as true recurrences is doubtful, for it is probable that they are really due to separate and fresh outbreaks of carcinoma often in quite different parts of the body, which have arisen owing to the fact that carcinoma is in some senses a general disease, but they show how careful we must be in accepting any period of years of freedom from recurrence as constituting a cure.

The outlook in atrophic scirrhus, duct-carcinoma, adeno-carcinoma and colloid carcinoma is undoubtedly better. Cases are occasionally seen in which a scirrhus and a pregnancy are both present; this is a strong indication for removing the scirrhus as soon as possible, as otherwise the influence of the pregnancy on it will be to make it grow very rapidly.

Operation for Carcinoma of the Breast. The operation as performed now for this condition consists in the removal of the whole of the breast (and it must be remembered how extensive an organ this is), the skin over it, the nipple, as much as possible of the fatty, subcutaneous fascia under the skin of the chest wall, the sternal portion of pectoralis major, the whole of pectoralis minor, and the complete axillary contents, comprising glands, lymphatic vessels, fat and fascia. This procedure should be effected through an incision which is roughly circular or elliptic, with prolongations at either end, and with its centre over the growth and not at the nipple, while all the structures excised should be removed in one piece. The overlying skin is removed because lymphatic vessels pass along the fibrous bands connecting it with the breast; the subcutaneous fat and fascia are extensively removed, because these are the layers in which the lymphatic vessels radiate in all directions, and by their permeation enable the carcinoma cells to spread. The nipple is removed because all the intralobular lymphatics converge to a plexus under it. The pectoralis major is also taken away, because certain deeper lymphatic vessels pass into the fascia over it and through its substance, while pectoralis minor is removed because, until this is done, it is impossible cleanly to dissect out the apex of the axilla. The axillary contents are, of course, removed, as in almost all cases the glands and lymphatic vessels there are found, either to the naked eye or microscopically, to contain carcinoma cells. It is, of course, essential that all incisions should be made wide of the disease and that no lines of lymphatic infection should be cut across.

The patient lies on her back with her head turned towards the opposite side, the arm tied up above the head to rather more than a right angle, and her body as near that edge of the table by which the surgeon is standing as possible. The axilla is shaved, the skin sterilised and sterile towels placed round to protect the operation area in the ordinary way. Various forms of skin incision may be employed, according to where the growth is (see Fig. 183), but they are all roughly elliptical, with prolongations at one or both ends, and have the growth as their central point; in making these skin incisions it must be remembered that the question whether we shall be able at the end of the operation to draw the skin together and suture it in the ordinary way is quite a minor one, but that, as a matter of fact, in most cases, wide undercutting of the skin, the formation of flaps, and the use of skin grafting, will enable extensive wounds to be closed in the most remarkable way. As it is always important to remove the fatty superficial fascia over the lower part of the chest and the upper part of the rectus sheath, it is important to carry one end of the incision down in this direction; while at the other end it is wise to see that the incision does not run directly across the axilla, but curves up above it on to the arm, as otherwise when it is healed there may form a strong band of scar tissue running across the axilla and tying the arm to the side. After making the skin incision, the first step is to undercut the skin widely in all directions, and this undercutting should be carried in the medial direction beyond the middle line of the sternum, upwards as far as the clavicle, downwards for 3 or 4 inches on to the abdomen, and laterally until both sides of the latissimus dorsi are exposed. The sternal and clavicular portions of the pectoralis major are then exposed and separated with a blunt dissector, the sternal portion is divided across as near its insertion into the humerus as possible, and the muscle is then retracted downwards; the border of the pectoralis minor is exposed and cleaned, and this muscle cut across as near its insertion into the coracoid process as possible and in its turn reflected down. The axilla is now completely exposed, and its contents must be removed by carefully dissecting the fat and fascia off the main vessels and nerves, off the subscapularis muscle at the back of the axilla, off the serratus magnus muscle on the chest wall, and off the latissimus dorsi at the outer side. If necessary, a portion of the axillary vein may be resected if any glands are adherent to it, but this is to be avoided if possible. The apex of the axilla must be cleaned particularly carefully, and care must be taken to preserve the nerve of Bell and the subscapular nerves, but the intercosto-humeral nerve may be disregarded. Throughout the operation any portion of the wound, at which the surgeon is not actually working, must be kept covered with warm, damp pads. When the axilla has been dissected clear all the tissues are retracted towards the sternum, and the surgeon returns to the outer side of the skin incision; through this he divides the attachments of pectoralis major and minor close to the ribs and sternum, gradually working inwards, and in this way completely severing the pectoral muscles with the breast and overlying superficial fascia, from the chest wall underneath. Finally, when the inner margin of the wound is reached, the mass of tissue to be removed is set free from the sternum and rectus sheath by a few touches of the knife. During this last stage of the operation there may be free bleeding from the perforating branches of the internal mammary artery, and these vessels must be quickly picked up, if possible before they are cut. It must be remembered that not only are these vessels somewhat liable to retract within the intercostal spaces, but that, if artery forceps with rather sharp points are employed to pick them up, these forceps may be pushed into the pleura accidentally. A huge wound is left, but when complete hæmostasis has been achieved, it is usually possible to draw the skin completely together by means of undercutting, flap cutting or other plastic procedures. If it is impossible to close it completely, on no account must the upper part of the wound be left open, as this will expose the axilla, and any bare area should be arranged to fall over the ribs; this can be covered with skin grafts in about ten days. Drainage for forty-eight hours is usually advisable to prevent the formation of a hæmatoma, and this is best achieved by a separate small incision at the back of the axilla. When the wound is dressed it is important to push a pad of dressings firmly up into the axilla to keep the skin in contact with the chest wall as far as possible, while the arm should be left free and the patient encouraged to move it away from the side as much as she will. The stitches should be left in for about eight to ten days, and it is of the greatest importance that the patient should be inspected every three months for some years after the operation to see if any signs of recurrence are present.

The operation is a major one and every precaution must be taken to diminish shock and loss of blood, either of which may be severe; but if properly conducted its mortality is exceedingly low, certainly less than 1 per cent.

If the supraclavicular glands are enlarged the incision must be carried up over the clavicle so that the posterior triangle of the neck also can be cleared of its lymphatic contents; some surgeons even recommend that this should be done in all cases, and it is possibly a wise proceeding whenever the axillary glands are extensively involved.

Some surgeons make a practice of separating the breast, fasciæ and muscles from the chest wall first, before opening the axilla, but by the above method, in which the axilla is dealt with first before the breast is touched, the bleeding is considerably diminished, as the greater part of the vessels are first cut and tied at their source in the axilla.

Post-operative treatment with deep ray therapy, or radium application, in a month to six weeks after operation is of definite value in preventing both local and general recurrence, and is carried out in all cases as a routine by some surgeons.

Local Recurrence. Local recurrence after an operation is due either to the growth not having been removed completely or possibly to infection of the wound with cancer cells during the procedure. It must be remembered that in the healthy individual the implantation of living cancer cells has apparently no effect, but that in a patient who is already the possessor of a carcinoma, implanted cancer cells almost always will grow and thrive, and every possible precaution therefore must be taken during the operation to prevent this. A recurrence occurs either in the skin near the scar, in neighbouring lymphatic glands, or in the sternum or ribs close by, and to prevent the likelihood of this, exposure to X-rays soon after the operation may be adopted as a preventative; the evidence as to the value of this latter proceeding is, however, not certain. Apart from local recurrences, at any time after the operation metastases in different parts of the body may occur, and once a recurrence has appeared, although its rate of speed will vary enormously, being in some instances exceedingly slow, and in others apparently more rapid than if no operation had been performed, nevertheless the patient's fate is sealed. Local recurrence usually appears in the form of nodules in the skin, pink or purplish in colour, and hard and fixed, but in other instances swelling of one or more ribs, or a prominence over the sternum, will denote that bony involvement has occurred.

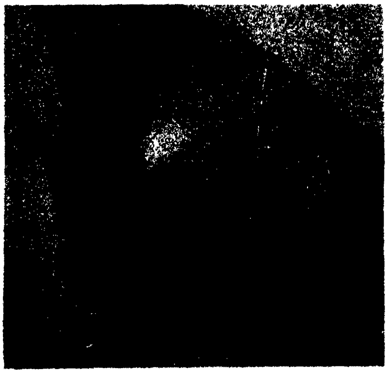


FIG. 182. Recurrence of a scirrhus eighteen months after operation. The recurrence lies in the skin above the scar and near the axilla.

In certain cases it is found that intense **solid œdema of the arm and hand,** evidently due to extensive lymphatic obstruction, will appear after an operation for cancer of the breast, and the whole arm and hand will become swollen, heavy, solid and painful and useless. If this appears within a few days of the operation, it is probably due to a very thorough clearance of lymphatic vessels and glands having been made, while in other cases it will appear within three or four weeks of the operation, and then be caused by an obstruction of lymphatics due to the formation of scar tissue. In neither of these instances is it necessarily a sign of evil import, but when, as is not infrequently the case, it commences some months or years after the operation, it is almost invariably due to an extensive, but probably impalpable, carcinomatous permeation of all the minute lymphatic vessels round the shoulder, and it is then to be regarded as a sign of the gravest import. If this solid œdema of the arm appears to be of the last type, and due to microscopic lymphatic recurrence, there is nothing that can be done for it except palliative treatment, but if the condition is due to a non-malignant lymphatic obstruction the operation of **lymphangioplasty,** in which long silk threads are introduced under the skin to form artificial lymphatics, usually will afford marked relief, but not a complete cure. In some cases the swelling and pain in the arm are so marked that amputation at the shoulder joint, or even an interscapulo-thoracic amputation, will be necessary.

FIG. 183. Incisions made in various operations on the breast. That on the right side is for carcinoma, and the shaded portion represents the area of subcutaneous fat to be removed. *A* marks the position of the lesion in the breast.

For the clinical signs due to recurrence in the liver, chest, spine, bones or brain, see Chapters I., XVIII., XI. and III.; and Vol. I., Ch. XVIII.

Inoperable Carcinoma of the Breast. When, for any of the reasons given above, the case can be regarded as unsuitable for a radical operation, it will be, nevertheless, often beneficial to the patient to excise the breast itself, without, however, interfering with the pectoral muscles or the axillary contents. In this way the occurrence of ulceration may be prevented and the patient saved from having a foul, discharging, bleeding, fungating wound with all its attendant unpleasantness and risks of sepsis. Beatson, of Glasgow, treated inoperable cases (provided the patient had not reached the menopause) by means of double ovariotomy and the administration of thyroid extract. No cure can be hoped for by this method, but in some cases the growth appears to have grown more slowly or even diminished for a time, while the pain and discomfort have been improved; we do not personally regard the operation as worth doing.

Radium and X-rays have been employed in connection with this disease—the former appearing to be the more useful—with three objects :—

1. One month after the operation radium needles or doses of deep X-rays may be employed as a prophylactic method in the hope that they will diminish any liability to recurrence. Hoffelder reports 75 per cent. cures by this means in cases traced for six years after operation.
2. In the case of recurrent growths. Here, as a rule, further operation is of no avail, but if the recurrences are superficial, these methods of treatment sometimes will produce alleviation, and in some instances even will cause nodules to disappear; the more rapid the recurrent growth appears to be, the greater is its chance of being affected by this treatment.
3. In cases which are inoperable from the first these methods of treatment will often produce shrinkage of the growth, and will lessen pain, hæmorrhage and discharge. For the methods of application employed in all these cases reference must be made to Ch. XXIII., Vol. I. Radium has recently been extensively used in inoperable cases (and also in operable growths), with the modern technique of small doses for prolonged periods (see Vol. I., Ch. XXIII.), and remarkable results have been reported in that the primary growth has disappeared. It is, however, too early to be sure that the patient's life is really prolonged, as secondary growths will still form, and many recurrences have occurred. 1 mgm. needles are used, and these are inserted in a circle round the periphery of the growth, in the axilla above the clavicle, along the border of the pectoralis major, and a needle in the anterior end of each intercostal space. These are left in for about ten days.

We do not consider that radium treatment alone is justifiable in operable growths.

Excision of the Breast. This operation is often performed for non-malignant conditions and is very much less formidable than the operation described above. The breast is dissected off the pectoral muscle, neither the muscle nor the axillary contents being interfered with, and this may be done either by means of an elliptical incision, surrounding the nipple, the skin area enclosed being removed with the breast; or else if the patient particularly desires that the nipple should be preserved, a flap method may be employed. If this method is adopted, a semicircular incision is made at the lower and outer periphery of the breast and the skin and nipple dissected up in the form of a flap. The breast can then be removed from underneath the flap, which is afterwards sutured back in place. The objection to this latter method is the liability of a large hæmatoma to form under the flap, while it will sometimes be found that the flap will slough. Whichever method is employed, it is wise to introduce a small drain for forty-eight hours.

For the operation of **lymphangioplasty**, see Vol. I., Ch. XI.

Incisions in the breast should be made, as far as possible, in a direction radiating from the nipple, while the lower down an incision can be kept the less likely it is to show in a patient when wearing low evening dress.

In the after-treatment of breast operations, one or two small doses of morphia may be given if necessary, while drainage should be employed for forty-eight hours. The arm should be drawn away from the patient's side and kept resting on a pillow in a fair amount of abduction, and early use encouraged. The only complication likely to occur is the formation of a hæmatoma which may lead to suppuration.

CHAPTER XIII

THE ABDOMINAL PARIETES AND PERITONEUM

Injuries of the Abdominal Wall and Peritoneal Contents. Diseases of the Abdominal Wall and Peritoneum. Peritonitis.

Surgical Anatomy. *The Abdominal Parietes* is the term applied to the structures enclosing, supporting and protecting the peritoneal-lined potential abdominal cavity, with its contained solid and hollow viscera. The parietes are completely invested by skin and subcutaneous tissue, which in the region of the anterior abdominal wall is specially modified into a superficial fatty layer (*Camper's fascia*) and a deeper fibrous layer (*Scarpa's fascia*); this latter takes the place here of the deep fascia, and is of importance to the surgeon in that its lower attachments affect both the direction of extravasated urine and a femoral hernial sac.

In the midline the fascia is carried down over the external genitalia and perineum as the *fascia of Colles* and *dartos fascia*, and, passing superficially to the male urethra, gets a firm attachment to the base of the triangular ligament and subpubic rami; this prevents fluid deep to Colles's fascia passing back to the ischiorectal fossæ and anus, and so directs it forwards and upwards over the genitalia and abdominal wall. Laterally the fascia is firmly attached, from the subpubic ramus outwards towards the great trochanter, to the fascia lata of the thigh, with which it fuses just below the crural canal at the saphenous opening, this attachment serving both to prevent extravasated fluid and a femoral sac from passing down over the thighs.

Deep to this integument the abdominal parietes are partly bony and partly composed of muscles and their aponeuroses.

The *bony portions* of the parietes consist of the vertebral column posteriorly (convex forward in the lower dorsal and lumbar regions, concave in the sacral and coccygeal regions, and forming in the pelvis the "hollow of the sacrum," in which the rectum is accommodated), which supports, above, the ribs, and below, the pelvis.

The lower seven or eight ribs, easily palpable externally, form a hollow frame supporting on their inner aspect, and in conjunction with the vertebræ and sternum, the domed sheet-like "diaphragm," which arches up steeply so as to reach the level of the nipples, and separates the abdomen below from the thorax above; moreover, slips of the transversalis muscle interdigitate with the diaphragm, and so prevent the ribs from actually abutting on the abdominal cavity.

The pelvis consists of (1) the lower basin-shaped "true pelvis," closed below by the fibromuscular "pelvic diaphragm" (levatores ani and coccygeus, and triangular ligament anteriorly), which serves to close in the abdominal cavity inferiorly and separate it from the ischiorectal fossæ and perineum, and is perforated in the midline by the outlets of genito-urinary and intestinal tracts; and (2) the expanded "false pelvis," supported by the lateral expansion of the iliac bones, covered by the iliopsoas muscles.

Posterolaterally, the vertebral column is flanked by the mass of the erector spinæ, anterior to which lie the psoas and quadratus lumborum muscles, arising from the vertebral column and last rib and passing down to the pelvis, and having the kidney and ureter on their anterior surface.

The anterolateral parietes (**anterior abdominal wall**) consist of a sheet of flattened muscles superimposed on one another, with their fibres passing in different directions and crossing each other: this gives additional strength to a structure constructed to yield to the distension of hollow viscera with food or gas and to accommodate itself to any shrinkage following evacuation of the intestinal tract, while, for the same reason, fairly large tumours of the solid viscera can be present with little or no discomfort.

The muscles forming the abdominal wall arise posteriorly from the ribs, vertebral column and pelvic brim, and pass forwards and downwards to be inserted into the midline of the body anteriorly (*linea alba*), and into the pubic ramus (as Poupart's ligament and the conjoined tendon).

It will be realised thus that the pull on the linea alba is always lateral, a fact which explains the broadening of this structure when weakened by debility and operative incisions; this permits "divarication" of the recti and the occurrence of umbilical and other midline herniæ, and incidentally shows why midline incisions should be avoided in abdominal operations.

These abdominal muscles consist of three sheets, which merit brief notice :—

(*a*) **The External Oblique,** which rises from the outer surfaces of the lower ribs and posterior pelvic brim, but which has *no* vertebral attachment, and so presents a free posterior border. Behind the lower end of the muscle, and in front of the origin of the latissimus dorsi from the iliac crest, there may exist a small space, "*Petit's triangle,*" through which a lumbar hernia or abscess may appear. The muscle fibres pass downwards and forwards and fuse over the anterior abdominal wall to form a strong aponeurosis, which passes forwards in front of the rectus abdominis to join with the aponeurosis of the opposite side in the linea alba. The lower edge of this aponeurosis, passing from the anterior superior iliac spine to the pubic spine and symphysis, presents a thickened margin known as *Poupart's* (*inguinal*) *ligament,* to which is attached inferiorly the iliac fascia lata of the thigh.

(*b*) **The Internal Oblique and Transversalis Muscles** arise from the lower and inner surfaces of the lower ribs, having the intercostal nerves passing forwards between them, from a common aponeurosis (*lumbar aponeurosis*) which gives them attachment to the lumbar vertebræ, and from the iliac crest and upper and outer part of Poupart's (inguinal) ligament, whence their fibres pass forward, and in the case of the internal oblique somewhat upward, to gain insertion into the linea alba. The aponeurosis of the internal oblique splits in the upper three-fourths of the abdominal wall to enclose the rectus muscle, while that of the transversalis passes behind it, except in the lower quarter of the rectus muscle, where both aponeuroses pass anteriorly and fuse with the external oblique aponeurosis. Those fibres of both muscles which arise from Poupart's (inguinal) ligament fuse and pass as a common tendon, arching above and then behind the spermatic cord or round ligament, to gain insertion into the iliopectineal line of the pubis and constitute the "*conjoined tendon.*"

This arching of the muscles above and behind the inguinal canal is important in the prevention of inguinal hernia (Chapter XIV., p. 580), and any damage to their nerve supply, as not infrequently occurs in McBurney's appendicectomy, undoubtedly predisposes to inguinal hernia consequent on paralysis of these fibres.

(*c*) **The Rectus Abdominis** (and inconstant *Pyramidalis*) consists of a broad band of muscle fibres passing from the pubes to the lower ribs and xiphisternum, and divided into segments by tendinous transverse septa (lineæ transversæ), which are usually four in number, two above, one at and one just below the umbilicus. These tendinous intersections are attached to the anterior rectus sheath, but not to the posterior.

The rectus muscle, as already mentioned, is enclosed by the splitting of the fused aponeuroses of the obliques and transversalis as they pass to their insertion in the linea alba, and this aponeurotic covering is usually called the *rectus sheath.* This sheath completely surrounds the muscle from a point midway between the umbilicus and symphysis pubis up to the ribs, and is formed anteriorly by the aponeurosis of the external oblique and the anterior layer of that of the internal oblique; while posteriorly it is formed by the transversalis aponeurosis and the posterior layer of the internal oblique, which, it will be realised, splits to enclose the upper three-fourths of the rectus muscle; in the lower fourth all the muscle aponeuroses pass in front of the rectus, there being no sheath behind to separate the rectus from the peritoneum. It is at this point that the deep (inferior) epigastric artery enters the sheath to ascend posteriorly to the rectus muscle to anastomose with the superior epigastric branch of the internal mammary. The lower edge of the posterior rectus sheath forms a well-defined crescentic ridge (*the semilunar fold of Douglas*), which must not be confused with the linea semilunaris, where the aponeuroses fuse at the outer edge of the rectus muscle.

The nerve supply of the abdominal wall is derived in its upper part from the forward continuation of the lower intercostal nerves, and in its lower from the subcostal nerve, and branches from the lumbar plexus, the iliohypogastric and ilio-inguinal nerves. These pass forward transversely between the internal oblique and transversalis muscles to enter the rectus sheath through the lateral edge of the posterior wall, and traverse the muscle which they supply before emerging as cutaneous filaments (except in the case of the subcostal nerve, which terminates in the pyramidalis muscle and has no cutaneous supply on the anterior abdominal wall). Each nerve gives off a cutaneous branch in the lateral line, which pierces the internal and external obliques to supply the skin; in the case of the intercostal nerves, that of the abdominal parietes, but in the case of the subcostal and iliohypogastric nerves these lateral cutaneous branches pass down over the iliac crest and supply the skin of the buttock; in the case of the ilio-inguinal, that of the scrotum, penis, and inner side of the thigh.

Roughly speaking, the cutaneous supply is as indicated in Fig. 184, Vol. I., the tenth thoracic supplying the level of the umbilicus, and the nerves passing round in the abdominal wall in a series of transverse lines as indicated.

The importance of realising the position of these muscles and nerves and their distribution is twofold:—

(*a*) In planning abdominal incisions it is essential as far as possible to avoid damage to these nerves, and the consequent paralysis of muscles with a tendency to ventral hernia (Chapter XIV., p. 605); while, as already indicated, incisions along the tendinous insertions of the muscles should be avoided for a similar reason.

(*b*) Branches from these nerves and their parent spinal segmental cells supply various abdominal viscera, and in inflammation and disease of these organs pain is frequently referred along the superficial branches of these nerves, the cutaneous areas of which are hyperæsthetic, so that a valuable indication is often obtained as to the internal organ which is at fault, *i.e.*, pain referred along the ilioinguinal nerve to the external genitalia and inner side of thigh in renal colic, and the hyperæsthesia around McBurney's point in appendicitis.

Remember that disease in the spinal cord or column also will give rise to *referred abdominal pain*, as is often seen in spinal caries and tabes dorsalis, a similar condition occurring in the upper abdomen in pulmonary and pleural lesions.

The Abdominal Cavity is the space enclosed within the abdominal parietes, and being practically a vacuum is merely potential, the area being occupied by the various solid and hollow viscera; these vary in shape and position according to the respiratory movements of the diaphragm and anterior abdominal wall, and the distension or otherwise of the various parts of the intestinal tract and, in the female, of the uterus. This cavity is completely lined by a smooth serous membrane (the peritoneum).

The Peritoneum is a serous membrane covering the inner surface of the abdominal parietes (parietal peritoneum), and more or less completely encasing the various abdominal viscera which project forward to a greater or less extent against the posterior surface of the membrane. It may surround a viscus almost completely (as the small intestine), being reflected back along its blood and nerve supply as a double layer (mesentery), or merely touch some part of the anterior surface (rectum and kidney), or even be kept entirely off certain viscera (third part of duodenum) by another organ lying anteriorly to these; such are said to be "*retro-peritoneal,*" though it will be seen from the foregoing that every abdominal viscus is really in this category, with the exception of the ovary in the female, which actually lies within the peritoneal cavity, being covered only by its germinal epithelium. At the junction of the various portions of the intestinal tract, notably in the region of the duodenojejunal and ileocæcal junctions, the peritoneum is thrown into a series of ridges or folds, and so pouches are formed which may be the seat of internal herniæ; for a full description of these, reference should be made to an anatomical textbook (see also pp. 543 and 686).

The peritoneal cavity is further subdivided by a series of reflections of its lining membrane into (1) the *greater sac*, which lies in front of the stomach and comprises the major portion of the peritoneal cavity; (2) the *lesser sac* (bursa omentalis), which lies behind the stomach and within the greater omentum, and is not opened unless this, the gastrohepatic omentum or transverse mesocolon are perforated.

Normally the two sacs communicate through the "foramen of Winslow," which lies beneath the neck of the gall-bladder and is reached by passing the finger up along the right side of that viscus, when the foramen will be found to be bounded behind by the vena cava, above by the caudate lobe (lobus Spigelii) of the liver, in front by the vena porta, with the bile-duct and hepatic artery lying anteriorly, all three enclosed in the right edge of the gastrohepatic omentum and below the duodenum.

Rarely the foramen may become obliterated by adhesions in inflammation of the neck of the gall-bladder or perihepatitis, when the greater and lesser sacs are separated.

The greater sac is further subdivided by the natural prominence of the transverse omental shelf and the ridges of the vertebral column, with the root of the mesentery of the small bowel and sacral promontory into what have been aptly described as "the peritoneal watersheds," which are of great importance in that effusions collect in them should hollow viscera perforate or peritonitis be present. These "watersheds" consist of (1) an upper compartment lying above the transverse mesocolon and great omentum, which, by adhering to the anterior abdominal wall, may completely shut off the upper from the lower area, and, moreover, in acute catastrophes in the upper compartment, *i.e.*, perforation of gastric ulcer, will direct fluid down to the pelvic cavity or up above the liver (subdiaphragmatic space). This upper compartment is the site of the various subphrenic abscesses which result when the inflammatory process localises as the result of adhesions (p. 543 and Fig. 192).

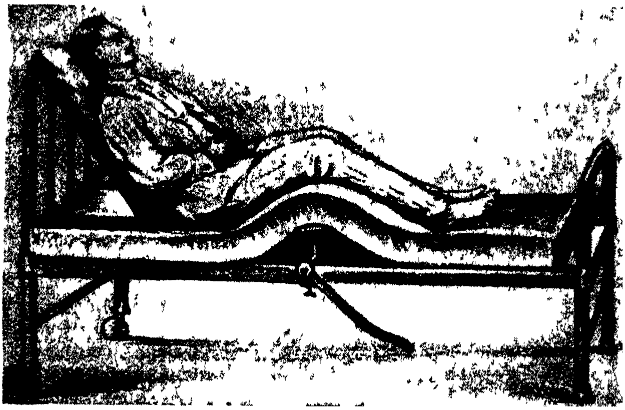


FIG 184 Patient in the "Fowler" position, supported by a bar and bed rest.

(2) The lower compartment is divided by the vertebral column, and the almost vertical attachment of the mesentery of the small intestine, above the pelvic brim into the two lateral renal pouches, and below the sacral promontory is the basin-like pelvic cavity with its deep recto-vesical or recto-uterine pouch (of which the vaginal vault forms the floor), sometimes known as the "*Pouch of Douglas.*"

The importance of realising the presence of these "watersheds" cannot be overestimated, and in all cases where fluid is found in the peritoneal cavity these must be carefully cleansed and dried out. At the same time, if it be realised that a lesion in the compartment above the omentum will flood the subdiaphragmatic region and pelvis only, while one below only can affect the renal and pelvic pouches, then time and the risk of spreading infection by unnecessary manipulation often can be saved.

It will be remembered that the *pelvic peritoneum*, though it absorbs freely, has far less stomata and absorptive power for effusions and their toxins than that portion of the membrane lining the under-surface of the diaphragm, and for this reason every attempt should be made to facilitate the flow of effusion into the pelvis, and the aid of gravity is invoked by propping the patient in bed in a semi-sitting position ("*Fowler position*"). But in all but the most acute cases omental and peritoneal adhesions often prevent free downward drainage and go far to annul the benefit of a theoretically sound position, so that, in our opinion, it should not be insisted upon if the patient's pulse and general condition are very feeble or if it distresses the patient to be maintained in the sitting position.

It is of interest to remember that the parietal peritoneum is very sensitive both to touch and stretching, so that its manipulation in a patient imperfectly anæsthetised is a potent cause of surgical shock during an abdominal operation, while, for the same reason, undue tension on, or rough handling of, retractors controlling wound edges will aggravate any tendency to collapse during an operation. Visceral peritoneum, on the other hand, is apparently insensitive, " colic " being the result of irregular spasm in the unstriped muscle of the bowel, ureter or bile-ducts. As already mentioned, however, pain from an inflamed viscus is constantly referred to the abdominal parietes.

ABDOMINAL OPERATIONS

The preparation for abdominal operations in no way differs from that described in Ch. I., Vol. I., and, except in rectal cases, there is no need to administer violent purges or enemata the night preceding operation. provided the patient's bowels have been kept regular for a few days before. In emergency cases purgation and enemata are strongly contra-indicated, as likely to aggravate both peritonitis and collapse, as is also extensive bathing, washing, or turning about of the patient.

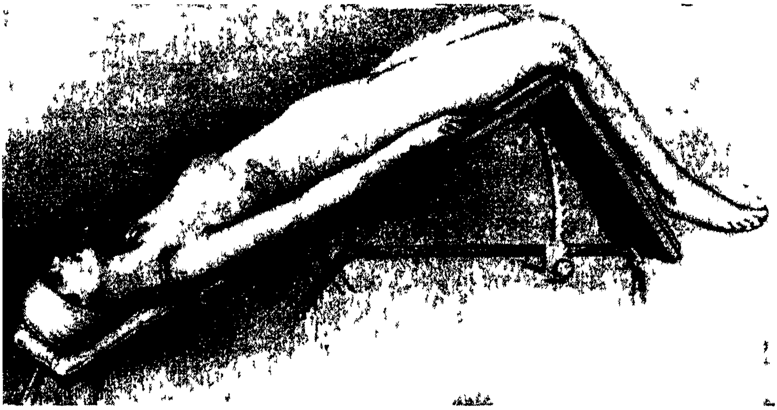


FIG. 185. Patient in the Trendelenburg position.

The incision for a "laparotomy," the term applied to an abdominal section. should be sufficiently large to permit of comfortable vision and handling of the affected viscera without exerting undue traction on the peritoneum or parietes, so as to prevent shock, as explained above; it, moreover, must be planned so as to avoid section of nerves or undue damage to muscles. As a rule midline incisions should be avoided, their replacement by a paramedian incision with outward retraction of the rectus, when the sheath is opened, being preferable. The *paramedian* incision gives a good approach to both the upper and lower abdomen, though some surgeons advocate *transverse* incisions, and either give a good exposure and a sound scar, with but little risk of post-operative hernia.

In order to procure as good a view as possible it is customary when operating on the upper abdomen to push the vertebral column forward by a mechanical support, or inflated bag, and in exploring the lower abdomen, especially the pelvis, much aid may be obtained by the use of the " Trendelenburg position " (Fig. 185).

The *closure of the wound* should be carried out by suturing the peritoneum, and then the abdominal parietes in layers, *i.e.*, aponeuroses, muscles and skin; where clips are used the subcutaneous fat needs suture to prevent the formation of a hæmatoma. As a general rule, and always in acute abdominal surgery, interrupted sutures are preferable to continuous, as they permit of opening up of one segment of the wound without its whole length gaping, and thus diminish the tendency to " bursting of the wound " and post-operative hernia.

Drainage of the peritoneal cavity, although practised by many surgeons, in acute peritoneal infections, is not only unnecessary in many cases, but may be even harmful; for, as shown by Dudgeon and Sargent, the fluid, which only escapes for the first forty-eight hours before omentum chokes the lumen of the tubes, contains more antibodies, aggressins and tissue cells than micro-organisms. Clinical experience further demonstrates that patients often do better if no drainage is employed, and that residual abscess is no more frequent; this is only to be expected seeing that the tube "drains" upwards. Should drainage be employed in general peritonitis, a counter-opening in the flank is satisfactory in upper abdominal lesions, and one through the post-vaginal fornix in pelvic lesions in women, but, as a general rule, swabbing out of pus, etc., with sterile gauze, followed by closure of the abdomen will give good results in such cases (p. 538).

When a *localised abscess* is present drainage, of course, will be resorted to, the tube being inserted as far as possible in the most dependent point, though such a collection of pus always must be opened at any point where it has reached the abdominal parietes, in order to avoid the very real risk of general infection, which follows evacuation of pus across the unobliterated peritoneal cavity (even when the peritoneum is packed off carefully this amounts to 20 per cent.). See also p. 542.

ABDOMINAL INCISIONS

It may be well to recapitulate briefly the chief abdominal incisions and to indicate what viscera may be approached through each. The actual length of the incision of course will vary with the obesity of the patient and the scope of the operation.

(1) The **Paramedian incision** may be made either to the right or left of the midline and at any level, but is usually made :—

(*a*) *Supraumbilical* (*high paramedian*), to explore the upper abdomen, stomach, liver, gall-bladder and ducts.

(*b*) *Subumbilical* (*low paramedian*), to explore the lower abdomen or pelvis, appendix, pelvic colon and rectum, bladder, and other pelvic viscera, and is much employed both by surgeons and gynæcologists.

Technique. A vertical incision of the required length is made just to one side of the midline and carried down through the subcutaneous tissues to the anterior rectus sheath, which is divided. The rectus muscle is then freed from the inner border and retracted outwards, the posterior sheath and peritoneum being divided vertically about one inch farther out than the anterior. Thus the rectus, when replaced, acts as a "trap door," and as the incision passes to its inner side no damage to nerves occurs and no weakness follows the operation. Should it be desired to increase the field of vision, it can be done easily by prolonging the incision at either end or by making sloping cuts from each extremity down to the anterior rectus sheath (Fig. 186).

(2) The **Pararectal incision** (Battle) is usually employed as an approach to the appendix, but the exposure is not satisfactory, and the liability to damage the nerves to the rectus, which is then paralysed, is great, unless the peritoneum is opened by a transverse incision.

Technique. An incision is made vertically over the outer third of the rectus muscle (midway between the umbilicus and right anterior superior spine to approach the appendix), the rectus sheath incised, and the muscle retracted inwards, care being taken to preserve the nerves. The posterior sheath and peritoneum should be incised transversely between two nerves, which are thus unharmed, but a very limited view is thus obtainable, and most surgeons divide the nerves and peritoneum by a vertical incision. A "trap-door" effect results, but if the rectus is paralysed a generalised abdominal bulging occurs, although actual herniation is uncommon.

(3) **McBurney's incision** for removal of the appendix is made just external to McBurney's point so as to avoid the semilunar line. A short oblique incision parallel to Poupart's ligament divides the skin, fat and external oblique aponeurosis, the underlying fibres of the internal oblique and transversalis are separated in the line of their course, care being taken not to damage the ilio-inguinal nerve (which results in palsy of the conjoined tendon and arch, and post-operative inguinal hernia, a complication seen in some 30 per cent. of cases), and the peritoneum is opened just over the appendix. The view is very limited, and should the appendix be adherent or the

cæcum misplaced the incision can be enlarged only at the expense of cutting across the muscle fibres, when a hernia is likely to result, as the "gridiron" effect of the crossing fibres is thereby neutralised.

A similar incision on the left side is often employed in iliac colostomy, though many surgeons prefer a transrectal incision, the muscle being split vertically, as this permits of either the transverse or pelvic colon being utilised.

(4) **Kocher's subcostal incision** is used on the right side to approach the gall-bladder, though many prefer a paramedian route, and on the left for removal of the spleen, when it is often curved up across the costal margin, which is split, together with the diaphragm, between the tenth and eleventh ribs, so as to give a freer approach to the organ.

Technique. The incision starts in the midline and is carried down and out parallel to, and about 1½ inches below, the costal margin. The rectus sheath is incised and the rectus muscle divided in the line of the incision, care being taken to avoid damage to nerves. The obliques are then split, one nerve, usually the ninth thoracic, being sacrificed in so doing. The wound is closed in layers, no attempt being made to draw the cut ends of the rectus together, as these approximate when the sheath is sutured.

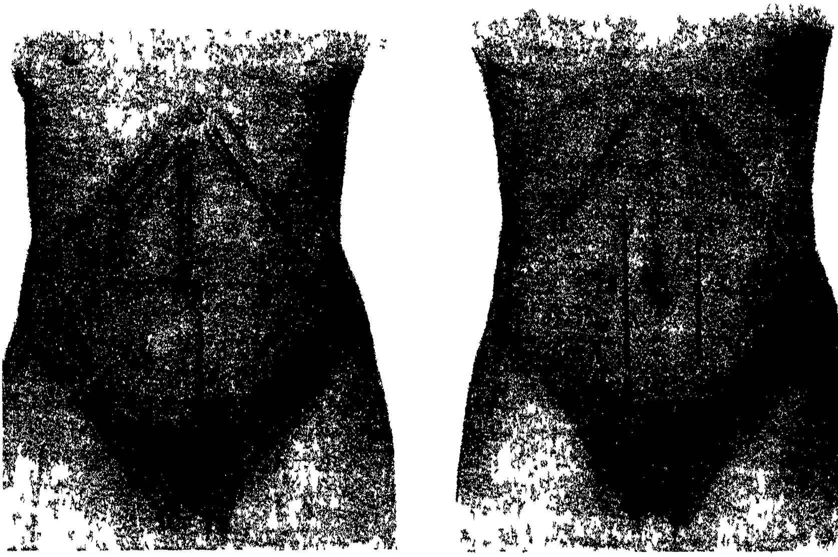


FIG 186 Diagrams to show skin incisions for abdominal operations. 1, 2. High and low paramedian. 3, 4. Transverse. 5, 6. Pararectal and Kocher's subcostal incisions for cholecystectomy. 7, 8. To expose the spleen and fundus of the stomach. 9. McBurney. 10. Transverse. 11. Battle's pararectal incision for appendicectomy. 12 Paramedian for exploratory laparotomy. 13. Transrectal. 14. Inguinal colostomy incision. 15. Inguinal herniotomy. 16. Prostatectomy (paramedian)

(5) **Transverse incisions** are becoming increasingly popular, can be made at any level, give excellent exposure and save damage to nerves. The rectus muscles are cut across, but unite readily when the sheath is sutured and give a sound scar and a strong abdominal wall.

Technique. The incision is carried from side to side or centre to side, at whatever level is necessary, the rectus sheath and oblique aponeurosis being divided in the line of the incision which passes between the nerves; the rectus is divided transversely, and the oblique and transversalis fibres are separated when the exposed peritoneum is opened. The wound is closed in layers.

The transverse incision can be employed advantageously in a modified form, the rectus muscle being retracted inwards and not divided, to approach the appendix and cæcum; an excellent view can be obtained and these organs can be easily turned out through the incision.

Technique. An incision is carried from the midline to the right at the level of the anterior superior iliac spines, the skin, fat, anterior rectus sheath and oblique aponeurosis are divided, and the rectus muscles retracted inwards. The internal oblique and transversalis can be split out as far as required and the peritoneum opened transversely.

In closing the wound care must be taken, after suturing the peritoneum, to approximate the cut ends of the outer border of the rectus sheath so as to re-establish the semilunar line.

(6) **Renal Incisions.** The kidney is nearly always approached through the loin, though in the case of large solid tumours of this organ the abdominal transperitoneal route should be employed.

Before starting the operation the patient is turned on the side and the iliocostal angle opened up by raising the lower loin on a mechanical support or air cushion. The upper leg should be straight and the lower knee and hip flexed.

Technique. (*a*) *The Lumbar incision.* The incision extends from the junction of the twelfth rib and outer border of the erector spinæ muscle downwards and forwards towards the anterior superior iliac spine. The skin and subcutaneous tissues are divided, the incision running ½ inch below and parallel to the last rib, and thus avoiding the subcostal nerve; the latissimus dorsi fibres, seen passing upwards and forwards, are cut across in the line of the incision ; the free posterior border of the external oblique is thus exposed and retracted forwards, when the dorsilumbar aponeurosis is seen and divided. The perirenal fat in Gerota's fascia is now exposed, with the peritoneum and colon lying anteriorly ; the soft kidney fat is separated from the true renal capsule and the freed organ can be drawn into the wound. It must be remembered that in the hilum the vessels lie anteriorly, the renal pelvis and ureter posteriorly.

(*b*) Some surgeons prefer the *vertical incision of Edebohl and Mayo*, which, however, may not give such a good approach unless nephroptosis is present, so that the use of this incision is best limited to the operation of nephropexy, unless more room is obtained by extending the lower end of the wound horizontally outwards. This is done by means of a vertical incision just inside the outer border of the erector spinæ, reaching from the last rib to the iliac crest. The sheath of the muscle is opened, its fibres retracted inwards, the posterior wall of its sheath is incised, the quadratus lumborum drawn backwards, and the perirenal fat exposed.

(*c*) The *abdominal approach* may be paramedian or pararectal, and transperitoneal, the colon being displaced inwards and the posterior peritoneal layer divided to its outer side so as to preserve its blood supply and vitality.

Any special modifications of incisions necessary in approaching individual viscera, or operative technique in such cases, will be dealt with in the appropriate chapters.

Post-operative treatment has been fully dealt with in Ch. I., Vol. I., and it will suffice here to draw attention to the necessity of securing rest and comfort to the patient, avoidance of too early and drastic purgation and enemata, and the advantage of an early return to a normal light diet, rather than long continuance of "slops," which promote flatulence and discomfort. In gastric and duodenal cases a diet on the lines advocated in Vol. I., Ch. 1., may be followed with advantage.

INJURIES OF THE ABDOMINAL WALL

The structure of the abdominal wall, backed by the presence of the gas-filled intestines, renders it elastic and resilient, so that blows either tend to glance off it, or the force of the injury is transmitted to the subjacent abdominal viscera in the majority of cases. The abdominal wall therefore tends, especially in unexpected accidents, to escape injury, except in severe cases, but enjoys this immunity at the expense of the abdominal organs, which are frequently severely damaged when the overlying abdominal parietes show no signs of bruising. Should a blow be expected, however, the abdominal wall muscles involuntarily contract to protect the viscera, and in this case present a rigid mass which is far more liable to damage, bruising or muscle rupture often occurring.

Such injuries are of little import, apart from the possible damage inflicted on the abdominal viscera, which is likely to be serious and, if not early diagnosed and promptly treated, will result in grave consequences to the patient.

Injuries of the abdominal wall fall into two great classes: (1) Wounds; (2) Contusions. *Burns and scalds* also occur, and are productive of great shock; if extensive, they are nearly always fatal.

(1) **Wounds** may be (*a*) non-penetrating, (*b*) penetrating, and are consequent on stabs or gunshot wounds, or occasionally from such accidents as impaling, or goring by a bull.

(*a*) *Non-penetrating wounds* call for no special notice beyond the necessity of ascertaining that the peritoneum is not opened and abdominal viscera are not ruptured by the violence of the accident.

Clinically they are obvious, and their treatment is cleansing and excision with suture of divided structures after hæmostasis has been secured (Ch. IV., Vol. I.). Surgical emphysema may occur round the wound for a short distance, owing to air being sucked in by respiratory movements.

(*b*) *Penetrating wounds* usually result in civil practice from stabs or revolver injuries, and in war from rifle, bomb, or gunshot wounds; very rarely a large hernia may burst as a result of violence, and the bowel protrude through the wound. It must not be forgotten that wounds of the perineum, buttock, flank and lower chest, as well as those of the anterior abdominal wall, may penetrate the peritoneal cavity and damage abdominal viscera, and occasionally air may be sucked in by respiratory or muscular movements, when surgical emphysema will result.

Clinically, the wound may vary from a pinhole to almost total destruction of the abdominal wall, according to the nature of the missile used; bowel or omentum may be prolapsed, or hæmorrhage be profuse. Shock may be slight or very marked, but it is usually present to some extent if viscera are injured, or the wound of the parietal peritoneum extensive; it is markedly absent in cases where the bowel protrudes from a burst hernia, as witness two cases which have been seen by one of us. In one of these an old lady fell on a pail and ruptured a large inguinal hernia and walked two miles to hospital supporting 20 feet of protruded small intestine in a red flannel petticoat, showing, on arrival, no signs of shock or exhaustion. The other case fell from a tramcar and sustained a fracture-dislocation of the neck of the humerus, for which she was brought to hospital, walking half a mile; this was reduced and splinted under gas, and the old lady, on standing up to leave, asked that her clothes might be removed, as she felt something warm and wet moving on her abdomen. This proved to be several feet of small bowel, and the transverse colon protruding through a large rupture in an umbilical hernia! Both cases made an uninterrupted recovery, after reposition of the cleansed gut, the wounds healing per primam.

Treatment. So soon as it is established that a wound has penetrated the peritoneal cavity immediate exploratory laparotomy is called for, and this will necessitate the prompt transference of the patient to a hospital where such an urgent operation can be conducted efficiently under aseptic precautions. If the bowel is prolapsed wrap it in a sterile towel, soaked in warm boiled water; do not attempt to replace it till the patient is in the theatre, and the bowel has been cleansed with sterile saline. When marked collapse is present a blood transfusion should be performed as an immediate preliminary to operation.

On opening the abdomen the whole length of the intestinal tract must be systematically searched for wounds of the bowel or omenta, starting from the stomach; the wounds are sutured and invaginated as they are met with, each section being returned to the abdominal cavity as a lower one is drawn out. Solid viscera must be examined, and hæmorrhage arrested by deep suture or plugging. The peritoneum should be sponged out with plugs wrung out in sterile saline, and the abdomen is closed without drainage unless very soiled.

In gunshot wounds as many as thirty or forty minute perforations may be met with in the course of the bowel, so repair may take a considerable time. Where a section of bowel is much destroyed, or the blood supply cut off by injury to mesenteric vessels, it must be resected between clamps (Chapter XVI., p. 702), and end-to-end anastomosis performed. Antitetanic and antigas-gangrene sera should be given prophylactically, and after-treatment carried out as suggested (Vol. I., Ch. I.).

The *prognosis* is good if the condition be dealt with immediately by laparotomy. Cases of extensive gunshot wound with laceration, or severe crushes with ruptured viscera, are rapidly fatal from collapse in many instances. Those cases in which intestine is protruded from ruptured herniæ usually recover if the bowel is cleansed and returned shortly after the accident. In late and neglected cases death usually results from general peritonitis.

(2) **Contusions** result from blows, crushing in buffer or run-over accidents, or from the kick of a horse or human being, and, as already stated, are very liable to be complicated by severe visceral injuries, even when apparently slight. It is for this reason alone that they are of interest and importance.

So far as the abdominal wall is concerned, bruising of the subcutaneous tissues is rare, but partial or complete rupture of muscles and aponeuroses may occur, especially if the blow has been anticipated, when a subcutaneous, intramuscular, or extraperitoneal hæmatoma is usually present.

Treatment. Provided it is established that no injury exists to subjacent viscera, no particular treatment other than that indicated in Vol. I., Ch. IV., is called for. Ruptured muscles and aponeuroses should be sutured and large hæmatomata evacuated, especially if in the flanks, as there is considerable risk of infection from the adjacent retroperitoneal colon, when a gas-containing abscess often results, which needs prompt incision and drainage.

INJURIES OF THE PERITONEUM AND SUBJACENT ABDOMINAL VISCERA

Injuries to the peritoneum do not exist apart from those of the subjacent viscera. As already pointed out, injury to subjacent viscera is a frequent and important accompaniment both of contusions and penetrating wounds of the abdominal parietes, and calls for prompt recognition and treatment in order to prevent fatal results either from the hæmorrhage consequent on injury to solid organs or the peritonitis which invariably follows on the escape of fluid or gaseous contents from damaged hollow viscera.

The dictum of Wallace that in all such cases, both doubtful and obvious, " it is safer to look and see than to wait and see," cannot be emphasised too strongly, and the necessity for prompt exploratory laparotomy should be impressed on the student, especially in those cases where doubt exists as to whether visceral damage has occurred.

As already stated (p. 514), unexpected blows are more liable to cause damage to viscera, the abdominal wall escaping except perhaps for a graze, than when the injury has been anticipated, for here the rigid abdominal muscles bear the brunt of the blow; in the case of wounds, expectation or otherwise makes no difference in the liability to visceral injuries, which depend on the velocity and course of the instrument or missile.

Clinically, the signs, both local and general, will fall into two great classes, according as to whether (1) solid or (2) hollow viscera are involved, with, of course, yet a third variety when both are involved. As already stated, in crushes, even when due to the passage of a 'bus wheel across the abdomen, only the slightest grazing may be visible externally; while wounds will vary much in size and appearance, and are by no means always obvious, especially in bullet wounds, where the punctured entry may escape notice, though the larger exit wound always is seen. Kicks in the abdomen, especially from a shod horse, always should be regarded as serious, as extensive visceral damage is all too frequently present.

(1) INJURIES OF THE SOLID VISCERA

The signs of damage to solid viscera are those of concealed hæmorrhage, though, in the case of wounds, some external bleeding may be present also: indeed, it may be severe.

(*a*) *General signs*, the chief of which are restlessness and dyspnœa, combined with an increasingly rapid and irregular pulse, pallor, and a cold, clammy skin, will be observed and steadily increase in severity in neglected cases (see Vol. I., Ch. IV.).

(*b*) *Local signs* will differ somewhat according to whether the hæmorrhage is (A) intra-peritoneal, *i.e.*, the peritoneal covering of the viscus is torn and the blood escaping into the peritoneal cavity; (B) extra-peritoneal, *i.e.*, the peritoneum is intact, and the blood escapes into the retroperitoneal cellular tissue around the torn organ.

(A) In **intraperitoneal hæmorrhage** the abdomen is seen to move poorly, if at all, on respiration; there is extreme tenderness of the abdomen, more marked on deep pressure, and so acute as to make the already restless patient writhe and cry out with pain. Generalised abdominal rigidity is rarely present, but the muscles may be contracted just above the injured viscus; usually there is no rigidity, and this is the case if the patient is in extremis. Fractures of the ribs, vertebræ, or pelvic bones may be detected.

On percussion the whole of the front of the abdomen is resonant or hyper-resonant as the distended bowel floats up on the blood; dulness may be detected in the flanks if the hæmorrhage is large, and the level can be found to vary if the patient is rolled on to the side from the back, "*shifting dulness*," which shows the fluid is free in the peritoneal cavity. Splenic blood tends to clot rapidly and cause a dull area in the left flank and hypochondrium. Auscultation may reveal feeble peristalsis, but usually all is still, as the upset to the sympathetic ganglia causes temporary paralysis of the bowel.

(B) **Extraperitoneal hæmorrhage** occurs usually only in connection with renal injuries, never with splenic ones, and the blood accumulates in a semifluid fluctuating mass in the flank, where it can be detected on palpation as an increasing diffuse swelling, which can be held between the hands, and often made to crepitate softly. Such a swelling may spread down along the ureter to the pelvis, and then resembles that occurring from injury to the iliac vessels in fracture of the pelvic bones. Usually the effusion becomes limited at times damaged in its extraperitoneal wall, infection leading to an abscess, frequently containing gas, is by no means uncommon. The prognosis is much more favourable in cases of extraperitoneal rupture.

Treatment. In intraperitoneal rupture this usually consists in nephrectomy through the abdominal wound, if the lesions of the other viscera and the patient's condition permit; occasionally hæmostasis may be secured by mattress sutures of catgut, but a drain must be carried out through a puncture in the loin, as urinary leakage is almost sure to occur.

In extraperitoneal cases, if effusion is slight, rest and a tight bandage are usually all that is required, but in severe cases lumbar incision, evacuation of clot and suture or removal of the kidney may occasionally be necessary. Very few cases, however, need urgent operation. An abscess, if it forms, must be dealt with by incision and drainage.

The **ureter** may be injured. It may be crushed or torn in an accident and has not infrequently been damaged in operations on the uterus or vagina, in resecting the cæcum or colon, or even in severe forceps deliveries. The condition resembles a rupture of the kidney except that there is more extravasation of urine and very little bleeding. In the operation injuries the ureter should be repaired at once if possible, otherwise an urinary fistula will form and this will probably necessitate a nephrectomy.

The **pancreas** occasionally may be crushed by blows in the epigastrium or damaged in wounds; it is seldom torn across. There is very severe shock, owing probably to damage to the sympathetic and semilunar ganglia, with very intense pain due partly to the digestive action of the pancreatic secretion on the tissues, and glycosuria may be present.

The case in many respects resembles acute hæmorrhagic pancreatitis (Chapter XIX., p. 764), with which it may be confused, for, as in this condition, fat necrosis is usually present on the omentum.

Damage to the *splenic artery*, *aorta* or *vena cava* results in severe hæmorrhage, which is rapidly fatal.

Treatment. Other lesions are usually present, and the condition calls for no special treatment unless the organ is severed, when it should be sutured and a drain carried back through below the costal angle. The tail, if avulsed in splenic injuries, should be excised.

Other Causes of Intraperitoneal Hæmorrhage. (*a*) *Damage to the aorta* or *vena cava* may lead to a rapidly fatal intraperitoneal hæmorrhage, but if the leakage is slow (as from a leaking aneurysm) rupture of the liver or spleen may be simulated.

(*b*) *Wounds of the mesentery and mesocolon* give rise to signs of intraperitoneal hæmorrhage, and may be mistaken for damage to viscera, but the situation of the wound in the parietes and the absence of injury above the costal margin should establish a diagnosis.

(*c*) *Ruptured ectopic gestation* in women who have usually missed one or two periods and show signs of early pregnancy, as well as sometimes having a palpable mass on vaginal examination, should give rise to no difficulty in diagnosis (p. 980).

(*d*) Occasionally large intraperitoneal hæmorrhages may occur in *hæmophilia* and *scurvy*, but such are usually retroperitoneal, and of course no operation must be contemplated.

(*e*) Rarely a *retroperitoneal sarcoma* or *renal neoplasm* may burst into the peritoneum and a severe hæmorrhage ensue; the patient in such a case is nearly always much emaciated.

(*f*) *Acute pancreatitis* and *ruptured ovarian blood cysts* also cause blood to appear in the peritoneum.

Treatment in all cases except in (*d*) and in obviously moribund patients is immediate laparotomy to secure hæmostasis.

Other Causes of Extraperitoneal Hæmorrhage. This may also occur (1) from rupture of the iliac veins in fractured pelvis, (2) from hæmorrhage into a retroperitoneal sarcoma (usually in young children), (3) in hæmophilia and scurvy.

Treatment, except in the last type when no operation must ever be undertaken, is to cut down and secure hæmostasis, by ligature if possible, if not by plugging.

It must be remembered that in rupture of the bladder (p. 526) intra- and extra-peritoneal extravasation of urine will occur, which may simulate hæmorrhage in these situations, but it commences in the pelvis, which is frequently fractured ; this also calls for prompt laparotomy or incision.

Traumatic Pneumothorax (p. 433) is caused often in crushing accidents, and results in marked collapse and some intrathoracic hæmorrhage. The condition may be hard to differentiate from intraperitoneal bleeding, and the two conditions often coexist. Where doubt is present morphia may be given, when, unless the pulse falls rapidly, laparotomy should be undertaken, even when the cardiac displacement shows a pneumothorax to be present.

(2) INJURIES OF THE HOLLOW VISCERA

The early signs of damage to the hollow viscera are very varied both as regards local and general manifestations, but in all cases where doubt exists immediate exploratory laparotomy is urgently called for, as if neglected there ensues a rapidly fatal general peritonitis (p. 533) consequent on the inflammation set up by the infection from the escaped bowel contents.

Generally speaking the early (*i.e.*, within a few hours of accident) signs of injury fall into one of three groups :—

1. Cases showing neither local nor general signs.
2. Those showing local and perhaps transient general signs.
3. Those showing both local and general signs.

(1) This type of case is very fortunately uncommon, but constitutes a dangerous trap not only for the student, but also for the experienced surgeon, who is all too liable to send such a case, which shows neither shock nor local tenderness or rigidity, home till the next day, when the patient appears with the signs of peritoneal infection so far advanced that laparotomy and repair of the damage are all too often unable to effect a cure. The patient, following a blow, kick or wound, walks into hospital perhaps having felt momentarily sick after the accident, or he may not consider it worth while coming to see the doctor at all, unless brought by friends or an employer. Examination is negative, the pulse is slow, and there are no signs of shock. The abdomen is not rigid or tender, moves on respiration, and shows no abnormality on percussion, but if the trouble is taken to auscultate *no peristaltic wave* is audible (p. 534), and this should cause the case to be admitted for observation. Should a penetrating wound be present immediate laparotomy is called for. If such a case is watched symptoms and signs as in types 2 or 3 will develop in a few hours and indicate that operation is necessary.

(2) The second class of case, and probably the most common, shows as regards general symptoms the phenomenon known as "delayed shock." At the time of injury abdominal pain, nausea or even vomiting may occur, but

this soon passes and the patient, beyond a certain amount of abdominal discomfort, experiences no general symptoms for some hours; after this the signs of shock and ultimately of collapse manifest themselves (Vol. I., Ch. IV.), the pulse getting weak and rapid, the skin cold and clammy, and the patient's facies becoming grey and pinched, no corresponding exacerbation of abdominal signs occurring to account for this.

The local signs are usually obvious from the first, the abdomen may show grazing or a wound and can be seen to move badly on respiration, especially over the region of the injury, and here tenderness and rigidity can be detected on palpation. On percussion a hyper-resonant note is usually obtained, which does not mean, however, that gas is free in the peritoneal cavity, as the bowel becomes paralytic and distended with flatus consequent on the accident; if, however, resonance can be demonstrated over the liver area, especially in the flank, where the colon cannot ride up if distended, it is safe to assume that free gas is present in the peritoneal cavity, and that the bowel is ruptured.

This "obliteration of liver dulness" is also present in perforation of gastric, duodenal and other intestinal ulcers (Chapters XV., XVI.), and it must be remembered varies in extent markedly within short intervals. Should a fluid-containing viscus such as the bladder, or a portion of the bowel full of fæcal contents be ruptured, dulness may be detected in the flanks, which will shift with the position of the patient and tend to increase in level with time. The extreme tenderness so noticeable in cases of intraperitoneal hæmorrhage is markedly absent. Auscultation shows entire absence of peristalsis in the affected area, though in early cases peristaltic waves can still be heard in other segments of the abdomen.

Pain is not usually marked in the early stages in this type of case, and amounts to little more than abdominal discomfort, but later pain of an intermittent colicky nature develops, usually radiating from the injured area. This onset of colic corresponds to re-establishment of peristalsis, and is often accompanied by a strong desire on the part of the patient to go to stool, when if the injury is in the small bowel a motion will be passed, though at the same time intestinal contents are evacuated into the peritoneal cavity. Later, when peritonitis supervenes, the pain changes in character and assumes the constant dull ache so characteristic of peritoneal inflammation (p. 533). If a wound is present gas and fæces may escape from it.

(3) The third variety shows early and marked shock as well as local signs, and is present in all those cases where solid as well as hollow viscera are damaged. The patient is brought up in a state of collapse, with a pinched, anxious facies, cold, clammy skin and weak, irregular and rapid pulse, usually in addition being somewhat restless and often incontinent.

The local abdominal signs are usually a mixture of those met with in intraperitoneal hæmorrhage and escape of intestinal contents as described in type (2) above; thus there is marked rigidity and tenderness of the abdomen, more obvious over the injured area, with hyper-resonance in the centre and possibly loss of liver dulness, and shifting dulness in the flanks.

Severe colicky pains are usually complained of and the patient often vomits. Should a wound be present, gas, fæces and blood may escape from it.

Diagnosis, as can be seen from the foregoing, will be very difficult in those cases where few or no signs can be detected, and such cases must be kept under constant observation, when, should any doubt still exist in an hour's time, exploratory laparotomy must be carried out. as it is far safer to look and see than wait and see.

In those cases where marked abdominal tenderness and rigidity are present in the region of injury, some doubt may exist as to whether these signs and the accompanying shock are due to injury of the parietes only, and here much help can be derived from a knowledge as to whether the blow or crush was expected or not. Expectation means rigid musculature, which will show signs of damage, and less likelihood of visceral injury unless the force was prolonged and great; unexpected violence will have found a lax abdominal wall, which will probably show no signs of injury beyond grazing, and this should lead to more than a suspicion that injury of viscera is present. The demonstration of free gas or fluid in the peritoneum of course clinches the diagnosis. The presence of a penetrating wound, even if no gas or fæcal matter is escaping, is very suggestive of visceral injury, and calls for immediate operation in any case to cleanse the peritoneum.

Rupture of the Stomach is of rare occurrence, and results from crushing injuries in the epigastrium, being therefore often complicated by laceration of the liver and spleen, fracture of ribs, and intrathoracic injuries. The prognosis is therefore grave. The stomach is only likely to be injured per se, if distended with food or drink, *i.e.*, just after a meal.

Clinical Features. Following the history of a severe crush or blow in the epigastric region, the patient complains of severe epigastric pain and nausea, at the same time vomiting and retching frequently, the vomit containing bright blood and usually being small in amount. The abdomen is rigid and tender all over, as the acid gastric contents run into the pelvis, but more markedly so in the epigastrium; should severe injury to surrounding viscera coexist, as is often the case, the signs of the gastric lesion may be overshadowed (see also pp. 517, 518, 612).

Treatment. This consists in instant operation and suture of the stomach wall, the best approach being through a transverse or high paramedian incision. The pelvis needs careful sponging out, and the liver and spleen examining before the abdomen is closed.

Ruptured Duodenum. See p. 636.

Ruptured Small Intestine is by far the commonest occurrence, both by reason of the central position and size of this part of the bowel, and probably represents about 90 per cent. of injuries to hollow viscera.

In the vast majority of cases the bowel is ruptured in one place only, but in perhaps 10 per cent. of cases multiple lesions exist following blows or crushing accidents, and this is commonly the case in stab and gunshot wounds.

The bowel may be ruptured completely, all coats being divided, or partially so, the peritoneal or peritoneal and muscular coats giving way and the intact mucosa bulging through the gap. In partial rupture actual escape of bowel contents does not occur, but peritonitis usually supervenes either consequent on infection by bacteria through the damaged mucosa, or from subsequent escape of bowel contents, following on gangrene of the damaged bowel wall. A similar infection may of course follow damage to or rupture of mesenteric vessels, the blood supply of an area of small intestine being thereby cut off.

Apart from actual penetration of the bowel by a knife or bullet in penetrating wounds, rupture from violence may be due to one of the following three causes:—

(1) *Crushing or nipping* of the bowel between the pelvic brim or vertebral column and the damaging agent, usually the hoof of a horse or some similar smallish object. Inasmuch as the ileum lies around the pelvic brim and

sacral promontory, injuries due to blows and kicks which crush and nip the bowel against bony prominences are usually met with in this lower and thinner part of the small intestine (ileum).

(2) *Torsion and tearing* will occur when the force drags across the abdominal wall, as in run-over accidents (where, if the vehicle be heavy and pass slowly, or come to rest on the abdomen crushing will also occur), and the bowel will then tear away at attached points, such as the duodenojejunal junction, and more rarely the ileocæcal valve, or the junction of the first and second parts of the duodenum. Tearing away of the root of the mesentery and rupture of mesenteric vessels are usually due to this type of violence.

(3) *Bursting* of a distended coil nipped at either end may perhaps occur rarely, and is more likely to do so if ulceration or scarring have weakened the bowel wall. Some few cases where intestinal rupture has followed grazing of the abdominal wall by a bullet, which has not perforated, would appear to be due to this cause.

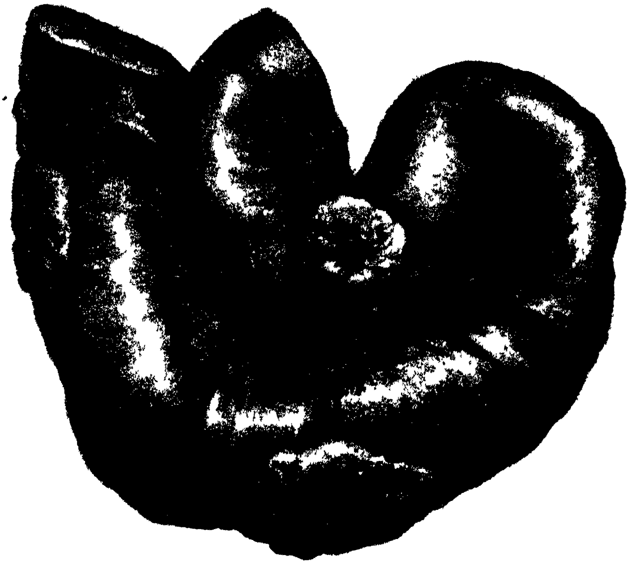


FIG. 189. Multiple bullet wounds in a coil of small intestine. Note the prolapse of the mucous membrane almost blocking the perforations in the bowel wall.

From the foregoing it will be seen that wounds of the small bowel, which are relatively common, will follow injury of the central area of the abdomen, and will vary in position according to the nature of the violence; thus, in kicks and blows, the ileum is likely to rupture, whereas in run-over accidents damage is more common at the duodenojejunal junction. In either case the lesion of the bowel is probably single, this not being so in gunshot and stab wounds, where multiple lesions are the rule.

Clinically, any of the three types of case described on p. 521 may be met with; the second variety, showing delayed shock, combined with abdominal rigidity and tenderness and absence of peristalsis obvious on auscultation, is the commonest unless solid viscera are damaged, when the coexistence of intraperitoneal hæmorrhage leads to the third variety, with marked general and local signs.

Treatment. In all obvious and doubtful cases immediate laparotomy must be carried out under aseptic conditions, a transverse or a low right paramedian incision being most useful unless clearly contra-indicated by the position of abdominal wounds. The intestinal tract must be searched methodically from above downwards for signs of injury, nor must the mesenteries and solid viscera be forgotten, even if an intestinal rupture be found. The bowel must be pulled out a few inches at a time, and each section examined and returned as the next is produced in order to minimise the risk of shock. The rent, when found, may be sutured, and the mucosa enfolded by a series of Lembert or Connell sutures of fine silk or thread, but if the bowel is much crushed, excision with end-to-end anastomosis is preferable. All perforations having been sutured, the peritoneum should be cleansed by swabbing with large gauze plugs wrung out of warm sterile saline, and the abdomen closed.

The *prognosis* is good if the case is treated within the first six or seven hours, and gets progressively worse as the time elapsing between injury and operation gets longer. When general peritonitis is present a fatal result is to be anticipated.

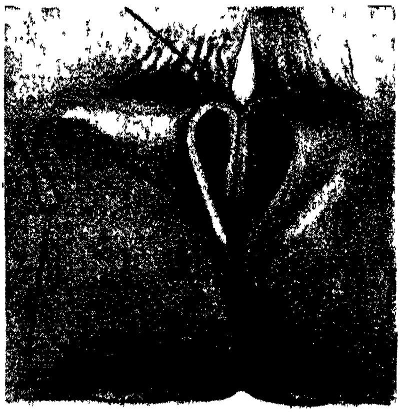


FIG. 190. The author's modification of Connell's stitch for intestinal suture in one layer.

Rupture of the Colon is very rare as a result of trauma, owing to the protection afforded by its position in the flanks, under the ribs and in the pelvis. As might be expected, the cæcum and transverse colon are most often injured, and these are more commonly wounded in stab and bullet injuries than in crushes. Owing to the highly infective state of the solid or semisolid contents, virulent infection of the peritoneum supervenes early, and the prognosis is not nearly so hopeful as in small bowel or stomach lesions.

Occasionally rupture of the extraperitoneal posterior wall of the descending and more rarely ascending colon may occur, when grave retroperitoneal infection will follow on surgical emphysema, often rapidly followed by gas gangrene. Suppuration will be present in the flanks and, if neglected, will spread into the buttock, pelvis and even down the thigh and up the chest wall (Vol. I., Fig. 75).

Clinically the condition usually follows wounds in the flank or region of the umbilicus, but may be associated with crushes in the loin, when hæmaturia from coexistent renal damage is often present. Gas usually escapes freely, and may bubble from a wound if present, but owing to the more solid condition of the fæces but little fluid escapes, unless the cæcum is wounded, when the semisolid contents escape and cause marked dulness in the right iliac fossa where they collect.

In most cases general signs are absent and local signs very slight, so that the first type of case described on p. 521, that with no symptoms, may occur; as peritonitis is rapid in onset and severe, owing to the infectious nature of the colic contents, such cases are all too often not diagnosed until peritonitis has supervened, even if seen soon after the accident. The presence of crepitation and a hæmatoma in the flank, especially the left flank, are very suspicious of retroperitoneal rupture.

Treatment. In colic rupture, above all other intestinal injuries, immediate laparotomy is called for, owing to the rapidity with which peritonitis supervenes; therefore, even in very doubtful cases, it is expedient to open the abdomen rather than wait and observe the case even for a single hour. The wound or wounds must be sutured and invaginated, and the peritoneal cavity thoroughly cleansed by wet swabbing and closed. In extraperitoneal rupture the colon is approached through the loin, the tear sutured, and the wound left open to drain and granulate.

Rupture of the Rectum. Owing to its situation in the sacral hollow the rectum is seldom injured except from wounds through the perineum and ischiorectal fossa, such as impaling on a spike; it, however, may be ruptured by the introduction of a foreign body through the anus, violence during sexual malpraxis, or over-distension by fluid or air, while occasionally a sigmoidoscope may be pushed through the bowel wall, usually at the recto-sigmoid junction. Enema nozzles have been forced through the wall.

Clinical Signs. Only if the anterior wall is torn in the upper part of the rectum will the rupture be intraperitoneal; in this case the signs resemble those of rupture of the colon, save that they are limited to the pelvis, and the lower abdomen alone is rigid and tender, while no gas can usually be detected in the peritoneum.

Extraperitoneal rupture occurs into the pelvic cellular tissue, and the infection, usually gas-containing, spreads out into the buttocks through the great sciatic foramina, and down around the anus through the pelvic outlet; later, thickening and crepitus spread above the pelvic brim.

Treatment. In any case of suspected wound to the anterior rectal wall, prompt laparotomy is indicated, with the objects of suture of the bowel and cleansing of the pelvic peritoneum.

Extraperitoneal rupture, if extensive, calls for transperitoneal exposure of the rectum to secure adequate suture of the rent, after which an incision should be made through the ischiorectal fossa and a rubber drain passed up to the rent through the pelvic cellular tissue; it is well to perform a temporary colostomy in these cases. If the wound is small, drainage of the pelvic cellular tissue alone may suffice, but is apt to be followed by the formation of troublesome fæcal fistulæ.

In cases where doubt exists as to whether the rectum is ruptured, a sigmoidoscope should be passed (Chapter XIX., p. 777), when the damage can be located and its extent ascertained.

Rupture of the Urinary Bladder is usually associated with fracture of the pubes, after crush accidents of the lower abdomen, the neck of the bladder being partly or entirely torn from the urethra; the urine is then extravasated into the pelvic cellular tissues, where it forms a boggy extraperitoneal swelling which increases in size and gradually ascends over the pelvic brim, unless the bladder is cut down on and the rent sutured. This condition of *extraperitoneal rupture* of the bladder is fully dealt with in Chapter XX., p. 861.

Intraperitoneal Rupture. If, however, the bladder is distended, and a sharp blow falls on the suprapubic region, the organ may be ruptured intraperitoneally, the upper wall being fissured longitudinally or transversely; such an accident may often follow a kick, or falling on the handle-bars of a bicycle, or on to a chair or stool, and as the patient is often semi-intoxicated, it may be difficult to elicit both history and symptoms. Occasionally rupture may follow introduction of an instrument or violent coitus.

Clinically there are the signs of free fluid in the peritoneal cavity, with dulness in the flanks, shifting in level with the position of the patient, who may be semi-intoxicated. If sober, pain and discomfort are complained of in the lower abdomen, following on a sensation of giving way and the loss of the discomfort of a previously full bladder, while tenderness and rigidity of the abdominal wall are evident above the pubes. There is often a desire for frequent micturition, small amounts of blood-stained urine being passed, while passage of a catheter may fail to obtain urine, unless the instrument can be guided through the rent in the bladder wall, when the end can be felt unduly prominent through the abdominal wall and urine can be drawn off from the peritoneum. A measured quantity of sterile water introduced through the catheter into the bladder cannot be recovered if rupture exists, as some escapes through the rent in the wall. Marked shock is usually present, and peritonitis supervenes even when the urine is free from infection.

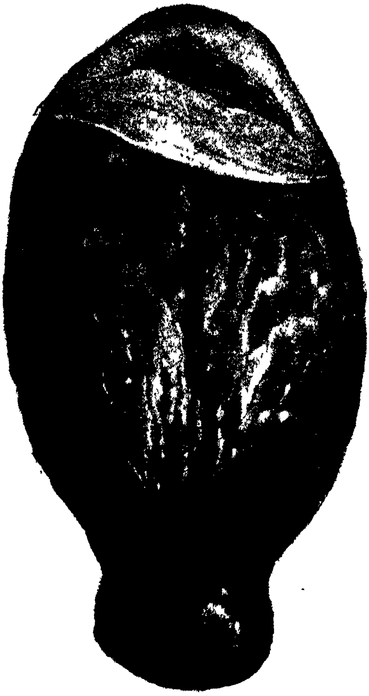


FIG. 191. Intraperitoneal rupture of the bladder.

Treatment consists in immediate laparotomy through a transverse or low paramedian incision, and suture of the rent in the bladder wall by means of two layers of catgut sutures, which may be interrupted or continuous; the first layer passes through all coats and should extend beyond the ends of the rupture, while the second includes peritoneum and muscle only, and serves to bury and invaginate the first layer of stitches. The peritoneal cavity should be swabbed out and closed, and a rubber catheter be tied in for some days.

Rupture of the Pregnant Uterus, which may occur rarely, as the result of blows or kicks in the suprapubic region in pregnant women, is dealt with in Chapters XXI., XXII., as is also *rupture of the Fallopian tube* and *ruptured ovarian cyst.*

Rupture of the Gall-bladder due to trauma is of rare occurrence unless accompanied by severe laceration of the liver, but it may follow crushes or blows in the right hypochondrium, especially if a hydrops or empyema of gall-bladder exist.

The condition is unlikely to be diagnosed apart from operation being undertaken on a diagnosis of rupture of an internal viscus, and is best treated by excision of the damaged gall-bladder (Chapter XVIII., p. 762). Occasionally what may be called a " subacute rupture " of the gall-bladder and bile-ducts occurs. After a fairly severe injury the patient rapidly recovers, but in a week or two, or even longer, epigastric pain is complained of, and a tense, round cystic swelling slowly forms. This is a bile-containing cyst due to leakage—it should be opened and drained.

DISEASES OF THE ABDOMINAL WALL AND UMBILICUS

Congenital abnormalities may occur:—

(1) The abdominal wall may be absent or so ill-developed that the abdominal contents project at birth into a sac of peritoneum enclosed in an expanded umbilical cord, and thus constitute a *congenital umbilical hernia* (see p. 601). The thin coverings usually slough and peritonitis supervenes, with fatal results.

(2) The lower abdominal wall may be absent with the anterior wall of the bladder, the posterior wall of which, with the ureteric orifices, is exposed and bulged outward by the pressure of the abdominal contents behind, constituting *ectopia vesicæ* (Chapter XX., p. 859), a condition always associated with *epispadias* (Chapter XXI., p. 894), and absence of the pubic symphysis.

(3) Meckel's diverticulum may remain patent, causing a *fœcal fistula* at the umbilicus, but more commonly it is closed and the distal portion alone persists as an **umbilical polyp,** which presents as a bright red, raspberry-like mass when the umbilical cleft is opened. Clinically, attention is usually drawn to the condition by a persistent mucoid or mucopurulent discharge from the umbilicus of the infant. Treatment, which consists in snipping away the polyp and, if necessary, touching the base with pure carbolic, gives satisfactory results. It should be realised that a Meckel's diverticulum often coexists.

(4) Rarely the stump of the allantois may remain patent, in which case a *urinary fistula* may give trouble, but the bladder usually does not empty through the umbilicus in these cases unless obstruction is present in the urethra, such as a post-gonorrhœal stricture. More often there is partial persistence of the allantois with the formation of a **urachal cyst** which contains clear fluid and may project at the umbilicus or lie deep to the subumbilical part of the linea alba. Such a cyst should be excised, and this operation must be most thoroughly performed if the duct is so patent as to cause a urinary fistula, the track being dissected out down to the apex of the bladder, where it is crushed and cut, and the stump invaginated.

(5) *True umbilical hernia* may be present in weak or rickety children, and more rarely in adolescent and even adult life; for its diagnosis and treatment reference should be made to Chapter XIV., p. 601.

(6) *Accessory nipples,* or more rarely mammæ, which may be single or

multiple, sometimes occur over the line of the rectus muscle, usually as raised brownish, pigmented areas; these are more common in females. Usually no treatment is called for, but in those rare cases where spheroidal-celled carcinoma arises in the rudimentary breast, free excision, together with the inguinal glands, is called for.

Pyogenic infections, such as cellulitis, abscess, or carbuncle, may occur in the skin and subcutaneous tissue, and in no way differ from these lesions elsewhere (Vol. I., Ch. IX.). They are particularly liable to arise in or around the umbilicus in stout or uncleanly persons, where retained secretion and dirt may give rise to a hardish brown mass (umbilical calculus or *omphalolith*), which may decompose and give rise to an offensive discharge and a septic dermatitis. It must be remembered that an abscess in connection with suppuration around abdominal viscera may " point," and involve the abdominal wall.

Various skin rashes, especially those of secondary syphilis, tinea versicolor, and scabies, occur on the abdominal wall, and a septic eczema or intertrigo is met with around the umbilicus and subumbilical folds in stout and uncleanly persons.

Tuberculous lesions occur either as a *tuberculous abscess* in connection with the lower ribs, which presents as a rounded fluctuant mass among the muscles in the epigastrium, becoming more prominent on hardening the abdominal wall, or as *lupus*, which is occasionally seen in this situation.

Tuberculomata, breaking down to form cold abscesses, also occur in the abdominal wall of children without connection with the ribs.

Primary syphilitic sores are not uncommonly met with in the suprapubic region, and are always accompanied by hard, painless, discrete enlargement of the inguinal lymph nodes. Secondary rashes are well marked in this situation, and gummata or gummatous ulcers are met with.

Actinomycosis is by no means uncommon, secondary to bowel infection, most often appendicular or cæcal, so that the disease is more common over the right iliac fossa (see Vol. I., Ch. VI.). The abdominal wall is thickened, hard and brawny, and shows multiple sinuses from which pus containing the typical granules and often fæcal matter escape. Treatment is of little use; formalin injection, iodides, sulphanilamides or vaccines may be tried. The Radium bomb and deep X-rays have been used with some success.

Typhoid abscess may occur in the rectus muscle, which becomes softened, enlarged and tender within the sheath, and may rupture on very slight provocation. The condition is seen only secondary to bowel infection. Other conditions in which **rupture of the rectus abdominis** may be met with, besides typhoid abscess, are tetanus, rabies and strychnine poisoning, apart from very severe strain and trauma, when the overtaxed muscle may give way. This sometimes occurs during parturition. The obliques are more rarely ruptured, but tend to develop obvious fibrous nodules in the scar (Vol. I., Ch. XIII.).

Operative treatment is usually not called for, as the sheath remains intact and prevents undue separation of the muscle ends; occasionally an incision may be required to check hæmorrhage, when suture with mattress stitches of strong catgut may be attempted.

Fistulæ occur at the umbilicus, or elsewhere, in connection with (1) the bowel, (2) the bladder, (3) the gall-bladder; these are usually secondary to suppuration or tuberculosis of these viscera, though the umbilical fistulæ of the bowel and bladder may be congenital in origin.

These fistulæ may heal with tight plugging, but if not, require an extensive operation to expose their origin, dissect them out and close them.

Pediculi pubis (crab lice) occur in the suprapubic hair, where they give rise to irritation and can be seen as small, reddish, rapidly moving insects, whose ova (nits) are adherent to the pubic hairs; they are best disposed of by shaving and bathing the area, and rubbing in mercurial ointment.

Varicose veins occur around the umbilicus in portal obstruction, constituting the stellate "caput medusæ" so characteristically seen in hepatic cirrhosis. Large masses of longitudinal veins are suspicious of thrombosis of the inferior vena cava, and are usually seen in post-typhoid cases. Operative interference is always strongly contra-indicated.

Epithelial neoplasms, warts and moles occur in the skin, and primary carcinoma or melanotic carcinoma may arise in connection with these, especially in or around the umbilicus. Excision is called for in all such cases. Secondary carcinomatous nodules may occur in the skin, showing as reddish, hard lumps, usually metastases from a breast carcinoma; or a solitary nodule may appear at the umbilicus secondary to a stomach, bowel or uterine cancer, the metastasis having passed along the lymphatics in the ligamentum teres. As mentioned on pp. 471, 489, scirrhous carcinoma may be met with rarely in connection with an accessory mamma.

Lipomata, neurofibromata, and simple fibromata are met with in the abdominal parietes.

Sebaceous cysts occur in the skin and *dermoids* may be met with in the midline.

Sarcoma may arise in connection with the subcutaneous tissues, aponeuroses or muscles. In this connection attention must be drawn to the prevalence of a chronic fibrosarcoma (**recurrent fibroid of Paget**), arising most often in the rectus sheath. Care must be taken not to confuse this with the hard fibrous nodules met with in the rectus and obliques usually in the subumbilical region of multiparous women, usually regarded as resulting from scarring consequent on rupture of muscle fibres during parturition.

The *recurrent fibroid of Paget* (desmoid tumour, cellular fibroma) usually occurs in the abdominal walls of young women as a firm, round, egg-like swelling, often movable, but fixed when the abdominal muscles are in action. It is very liable to recur locally after removal.

When confronted with a tumour which appears to lie in the abdominal wall, it should be remembered that tumours of the abdominal wall lying in front of the rectus become more prominent and are fixed when the rectus is put into action—they do not move up and down on respiration. Tumours of the rectus or within the rectus sheath are not altered in prominence when the muscle is put into action, they also are fixed by this action, and do not move up and down with respiration; whereas tumours inside the abdomen become less prominent when the rectus is put into action, and are not fixed by it. They may or may not move with respiration.

DISEASES OF THE PERITONEUM

Inflammatory reaction in the peritoneal membrane is in the vast majority of cases secondary to infection of the intestinal wall with organisms from the bowel, as in appendicitis, or following escape of bowel contents in perforations or traumatic ruptures of the intestinal canal. Occasionally, peritoneal invasion may occur as a direct infection following a perforating wound, or, in the female, as an infection via the Fallopian tubes, in which case it is usually gonorrhœal (Chapter XXII., p. 974); it also occurs as a blood-borne infection in septicæmia, and as a primary pneumococcal or streptococcal peritonitis (pp. 548, 547).

In either secondary or primary peritoneal infection the resulting inflammation may be acute or chronic according to the virulence of the micro-organisms and the local reaction of the tissues. This local reaction in the peritoneum, as might be expected from an endothelial membrane, is usually brisk, so that localisation of the infection often occurs, and this is further aided by the vascular great omentum which wraps around and encircles any inflamed abdominal viscus. In very acute cases, however, generalised peritoneal infection occurs, and this also may follow failure of the attempts at localisation often due to tearing away of the omentum or adherent coils of bowel, consequent on violent peristalsis set up by the injudicious use of purgatives and enemata in such cases.

Peritonitis. It will be seen from the foregoing that *peritonitis* falls clinically into two great classes : (1) Acute, (2) Chronic ; and that each of these may be either (*a*) localised, (*b*) generalised, according to the virulence of the infection and the local inflammatory reaction produced in the peritoneum and great omentum.

The question as to whether the peritonitis is secondary or primary is of very secondary consideration from a clinical standpoint, though "*for all practical purposes peritonitis always may be regarded as arising secondarily to infection from some abdominal viscus.*"

Primary peritonitic infection is extremely rare, and the majority of cases so called are really part of a generalised septicæmia, a true primary peritonitis arising only as the result of infection of a wound involving the peritoneum without injury to viscera, a very rare accident.

Ætiology of Peritoneal Infection. As already stated, peritonitis is almost always due to bacterial infection, when, as might be expected, the normal flora of the intestinal canal play an important part; for these micro-organisms, harmless normal inhabitants of the bowel lumen, produce acute inflammation when implanted on the peritoneum. Aerobic micro-organisms, such as Bacillus coli, B. pyocyaneus, B. proteus, and many saprophytic and gas-forming organisms, are frequently met with in the peritoneal exudate, mixed with the commoner pyogenic staphylococci and streptococci; for peritoneal infection is usually mixed, as might be expected when it is considered that infection occurs through the bowel wall from the intestinal tract. Anaerobic organisms, as B. welchii, are seldom met with, apart from mechanical or paralytic obstruction of the small intestine; even then they are usually within the bowel lumen. In the vast majority of cases B. coli and staphylococci predominate, though research demonstrates that in the late stages of peritonitis, when paralytic distension of the small intestine has allowed the contents to stagnate, B. welchii usually can be cultivated in large quantities from the intestinal contents, and it would appear that some of the toxæmia in peritonitis is due to this organism in the bowel.

In some cases gonococci may be present in pure culture, or pneumococci or streptococci may exist alone in the peritoneal exudate; while more rarely the influenzal bacillus, malarial parasite, or streptothrix of actinomycosis may be found.

B. tuberculosis is a frequent cause of chronic peritonitis, and may reach the membrane either from the bowel or the blood stream.

Rarely no organisms can be cultivated from the peritoneal exudate, as when foreign bodies are left in the peritoneum, or following exudation consequent on rupture of an ovarian cyst or contusion of the abdominal parietes, and in these very infrequent cases the peritonitis must be regarded as a plastic or aseptic reaction to the trauma.

It will be realised that peritoneal inflammation is like similar reactions to irritation in any other tissue of the body, but it produces one important complication, which is serious in its results and much modifies the ultimate course of the inflammatory reaction. Consequent on the peritoneal inflammation, Nature endeavours to secure rest to the inflamed area, with the result that peristalsis of the bowel ceases and the musculature relaxes, thus allowing distension of the bowel and stagnation of its contents, with the risk of secondary infection of the peritoneal cavity by the micro-organisms from the decomposing intestinal contents, apart from the toxæmia induced locally in the bowel wall. This paralysis of the bowel wall allows distension and flooding of the bowel with serum from the vessels of the mesentery. Thus the patient becomes collapsed from withdrawal of fluid from the circulation, and, in addition, an acidosis develops as the chlorides and other salts in the blood in circulation are diminished.

Thus the surgeon is faced with the difficult problem of either disturbing Nature's attempt at rest, and incidentally breaking down adhesions between coils of bowel or other peritoneal surfaces which are limiting infection, or running the risk of the toxæmia from the bowel contents destroying the patient. Hence the treatment of peritonitis cases has fallen into two sharply separated schools, both of which are agreed as to the importance of keeping up the patient's fluid intake, best by intravenous drip infusion of gum saline with glucose :—

(1) That which aims at procuring rest for the inflamed area as the first principle of treatment, regarding purgation as of secondary importance, and indeed viewing all attempts at early and violent efforts to open the bowels by purges or enemata as actually harmful, in that they tend by promoting active and irregular peristalsis to break down adhesions and spread infection. This school rightly points out that all efforts to produce an action of the bowels are usually ineffective if peritonitis is present, and merely distress the patient and aggravate the vomiting, which can be prevented by the giving of intravenous salines to which a slight excess of salt and some glucose have been added.

(2) That which endeavours by early and violent purgation to eliminate the bowel toxins and so prevent the risk of secondary infection and local and general toxæmia. Here it must be admitted that efforts at purgation early in bowel infection often break down adhesions and cause a local inflammation to become generalised ; at the same time they produce no action of the bowels in many cases, as the paralysed muscles refuse to contract in the inflamed area, though they will do so above and below ; this tends to produce vomiting, while at the same time it empties the lower part of the large intestine if full.

B. W. Williams has suggested that the toxæmia in peritonitis, which much resembles that seen in gas gangrene, may be due to an excessive B welchii growth in the bowel, the toxins of which, both in the intestine and peritoneal exudate, can be shown to be greatly increased following stasis in the small intestine ; excellent results have been obtained in some cases by the use of anti-B. welchii serum, both as regards saving of life and the production of bowel action by counteracting the toxic paralysis of the muscle of the bowel wall and so restarting peristalsis in apparently hopeless and moribund cases of peritonitis.

Brockman, on the other hand, believes the absence of bile and pancreatic secretion in the lower ileum and cæcum is responsible for the obstinate constipation, and collects the patient's vomitus (which contains these) and administers it as a high enema, in many cases with success; others give ox bile enemata or acetylcholine 0·1 gram hourly for five or six doses. In all cases salines must be given intravenously to replace fluid loss and counteract acidosis.

ACUTE PERITONITIS

Acute peritoneal inflammation is practically always the result of bacterial infection, usually with aerobic organisms, commonly through the bowel wall, but occasionally brought thither by the blood stream in septicæmia. Rarely, however, an aseptic peritonitis may occur as the result of trauma, or consequent on the presence of foreign bodies in the peritoneal cavity.

Dudgeon and Sargent, working on the bacteriology of peritoneal exudates, have found staphylococcus albus in the blood clot and serous effusions of these apparently aseptic cases, and it is doubtful, even in cases of retained aseptic bodies, such as swabs and instruments, if bacterial infection in a mild degree does not occur from the bowel consequent on the peritoneal irritation.

Acute peritonitis, whether generalised or localised by inflammatory reaction, is, as already pointed out, in the vast majority of cases secondary to inflammation starting in some abdominal viscus, usually the bowel or some hollow viscus connected therewith; but in the female it is also secondary to infection of the genital canal, and it will be therefore, in the first place, in the region of the inflamed viscus. It may be helpful to epitomise the primary seats of infection on which peritonitis may follow:—

(1) Any part of the intestinal tract from the cardiac orifice of the stomach to the rectum. Peritoneal infection may follow on traumatic or pathological rupture of the bowel wall, or from bacterial infection via the blood or lymph supply consequent on localised inflammation of some portion of the intestinal canal due to bacterial invasion of its wall, contusion, or gangrene consequent on interference with the blood supply.

(2) Similar conditions may prevail in relation to other hollow viscera, either in connection with the digestive or urinary tracts.

(3) In the female, injury or infection of any part of the genital canal is a potent source of infection, and is usually gonorrhœal (Chapter XXII.).

(4) Blood-borne infection in various forms of septicæmia, *i.e.*, streptococcal, pneumonia, tuberculosis (rarely acute), malaria, influenza, acute rheumatism.

(5) The action of irritant fluids, such as bile, pancreatic juice and urine, which are normally sterile

(6) Rarely direct infection consequent on perforating wounds.

Acute Spreading Peritonitis. The origins of this condition have been discussed already on general lines, and it only remains to draw attention to such common causes as appendicitis, perforation of gastric and duodenal ulcers, acute cholecystitis, acute pancreatitis, rupture of bowel or bladder, neglected strangulation of a hernia, volvulus, intussusception, etc., to realise in how many regions peritonitis may occur and spread if these conditions be not promptly diagnosed and dealt with by the surgeon.

Clinically the peritonitis will commence in the region of the infected viscus, and if this be promptly dealt with will remain localised to this region and rapidly resolve; otherwise it will become generalised. It must be remembered that its symptoms are closely intermingled with those of the causative condition. The patient will complain of pain of a continuous dull, aching character, quite different from the sharp intermittent pain which is met with in obstruction or colic, due to peristalsis of an irregular character. This aching pain is usually generalised at first, or centred around the umbilicus, but in the course of a few hours localises over the inflamed area. Often, as a result of the abdominal discomfort, an attempt is made to evacuate the bowels; this is often successful, but produces no relief.

On examination there is marked tenderness over some area of the abdomen, which is mainly in the nature of a hyperæsthesia, though a sickening sensation persists on deep pressure.

The muscles over the affected region are rigid (except in pelvic peritonitis or in old people with feeble muscles), and the area does not move with the rest of the abdomen on respiration; indeed, if the peritonitis is at all extensive, the whole belly is held rigid and the respiration is thoracic in type.

The cutaneous reflexes may be normal, exaggerated, or absent—the muscles around the inflamed area react briskly and harden promptly when the abdomen is palpated.

Auscultation of the abdomen with the stethoscope should be practised always, and its value cannot be too strongly impressed on the student. That this means of diagnosing between peritonitis and obstruction of the intestine in their initial stages is the only certain method is demonstrated time after time, although auscultation is unfortunately all too often neglected.

On auscultation no peristalsis can be heard in the affected area when peritonitis or inflammation of the intestinal wall is present, and there is only weak and sluggish peristalsis in the region around. Friction sounds may at times be heard in the abdomen in early cases of peritonitis.

In the early stages normal peristalsis is present in the other quadrants of the abdomen, and the characteristic rhythmic sound as of a finger being drawn across a sheet of wet rubber can be heard occurring roughly twice a second. In cases of obstruction of the bowel violent, loud and irregular peristalsis is present; this forms a marked contrast to its absence and the consequent complete silence heard on listening to the abdomen when peritonitis is present.

Percussion of the abdomen yields no useful information, the distended bowel giving a tympanitic note, and as this method of examination causes pain it should not be attempted; in the later stages a mass may be palpable, and if this is covered with intestine a tympanitic note is obtained, whereas, if it is formed by a mass of omentum, or by pus directly in contact with the parietal peritoneum, a dull note is yielded on percussion, unless a gas-forming organism be present, when it may be resonant.

General signs will be present, though these may be slight in very early cases. The tongue is brown and furred, and the breath has a characteristically fœtid odour. Obstinate constipation is present, though in this early stage the large bowel may be emptied once and flatus may be passed. Vomiting will occur, but is inconstant and never fæculent, at this early period. The temperature is usually raised to between 99–101° F., and the pulse rapid, this rapidity increasing markedly as the infection spreads, while the temperature tends to fall as the toxæmia increases. The facial expression is anxious, and there may be sweat on the forehead and around the nose. The patient usually lies on the back with the knees drawn up to relax the abdominal muscles, and if the peritonitis is in the pelvis he may complain of pain on micturition, more marked towards the end of the act, but present throughout; retention may be present. In the later stages the typical "facies Hippocratica" with sunken eyes, sets in.

Prognosis. The peritonitis often will not remain localised to the area of the infected or obstructed viscus, unless this is promptly removed, when resolution will occur. Should no operative interference take place the peritoneal inflammation may either :—

(1) *Localise* as a result of the reaction in the peritoneum and omentum, which adheres around the inflamed viscus, forming a mass of omentum and adherent coils of intestine in the centre of which suppuration often occurs and an intraperitoneal abscess results.

(2) *Diffuse* generally throughout the peritoneal cavity, sometimes after an unsuccessful attempt at localisation, when death almost inevitably results from the intense toxæmia. This condition usually arises in cases where interference with the blood supply to any viscus, either from trauma, mechanical obstruction or inflammation, results in its complete gangrene, or localised perforation, and also when actual escape of fæcal contents occurs into the peritoneal cavity.

If prompt operation be undertaken in the early stage of peritonitis described, and the local cause is identified and eliminated, the prognosis is very hopeful; it therefore follows that in peritoneal infections in septicæmia, *i.e.*, where no local cause exists in the abdomen, the prognosis is bad, *e.g.*, pneumococcal peritonitis.

Pathology. If the abdomen be opened in this early stage the visceral and parietal peritoneum in the affected region is seen to be red and less shiny than normal, and the vessels injected, these changes being most marked on the surface of the infected viscus. There is often an exudate of clear straw-coloured serum, from which bacteria may be grown in some cases, and in the later stages this may be turbid or even purulent; at first localised to the affected segment of the abdomen, the exudate later becomes generalised and may be copious in amount, collecting in the most dependent "watershed" areas, *i.e.*, the pelvis and flanks. In this exudate the causative micro. organisms, which in the vast majority of cases, as shown by Dudgeon and Sargent, are aerobic and most often B. coli with Staphylococcus aureus or albus, can be isolated.

As resolution occurs the serolymphatic exudate clots and organises on the peritoneal surfaces, which lose their glossy, smooth appearance and adhere one to the other. These adhesions consist of typical granulation tissue and usually disappear in from two to three months if resolution occurs, but they may persist longer and even organise into dense fibrous bands, which are a potent cause of intestinal obstruction (Chapter XVI.), besides causing pain and constipation consequent upon "adhesions" between coils of bowel which are attached to each other or to the parietal peritoneum.

Differential Diagnosis. At this early stage the diagnosis is usually clear if careful attention be given to the dull aching pain, localised tenderness and rigidity, hyperæsthesia and absence of peristalsis, but occasionally some difficulty may be experienced in determining the cause of the infection. This, however, is of secondary importance so long as the presence of early peritonitis is recognised and the necessity for immediate operation realised and insisted on. Certain pitfalls do exist, however, and may make the diagnosis extremely difficult in some cases.

(1) *In cases of pleurisy or early pneumonia* pain may be referred to the

abdomen, usually to the hypochondrium, but occasionally to the iliac fossa on one or other side, and marked muscular rigidity will be present in this region ; but the pain is usually of a sharper stabbing character than that seen in peritonitis. Hyperæsthesia is present, but there is no discomfort on deep pressure. On auscultation peristalsis is normal or rather brisker than normal. No abnormal physical signs may be detected in the chest, but the respiration rate is usually raised and the alæ nasi may be working in children, in whom also vomiting is often present at the commencement of acute pulmonary infections. It must be remembered that pneumonia and pneumococcal peritonitis may coexist in the same patient.

(2) *Early intestinal obstruction* gives rise to abdominal pain of an intermittent colicky nature, and on auscultation increased and irregular peristalsis can be detected.

(3) *In the abdominal crises of tabes dorsalis* the pain is very acute and retching persistent, while other signs are present. There is a history of recurrent similar attacks.

(4) *In colic* of intestinal, renal, or biliary origin there is intermittent pain and vomiting, and usually sweating is present. The pain is referred in renal colic to the thigh, perineum and external genitalia and in biliary colic to the back and right shoulder, and in both these cases peristalsis is normal on auscultation. *Intestinal colic* may present greater difficulties in diagnosis, especially if due to lead, when obstinate constipation is present and usually also a blue line on the gums ; but the intermittent pain, often relieved by the pressure of the examining hand, increased peristalsis audible on auscultation, and the frequent presence of diarrhœa, which affords at least temporary relief, are generally characteristic.

(5) In *spinal caries*, especially in children, pain is often referred to the abdomen, and any dull, persistent "tummy ache" should lead to examination of the spinal column, both actually and by X-ray photographs.

(6) In *uræmia* peritonitis is not infrequently closely simulated, and as owing to the toxæmia intestinal stasis is often present, only an examination of the urine will establish a diagnosis, in the absence of drowsiness, fits or renal œdema.

(7) In any infections such as *influenza* and *malaria*, invasion of the peritoneum may occur, producing an actual peritonitis, and it may be impossible to make up one's mind as to whether any intestinal calamity be present in addition. In case of doubt it is far safer to look and see, and that promptly.

(8) *Contusions of the abdominal parietes*, as already noted (p. 516), produce pain, tenderness and rigidity with reflex arrest of peristalsis, and here again if any suspicion exists that visceral damage and peritonitis be present, always operate promptly and do not wait and see.

(9) *Blood in the peritoneal cavity* after trauma or rupture of an ectopic gestation (Chapter XXII., p. 980), or even retroperitoneal hæmorrhage as in sarcoma, trauma, scurvy and hæmophilia, may cause symptoms simulating peritonitis ; but here the pain is agonising and the tenderness more marked on deep pressure, while peristalsis, though feeble, usually can be detected on auscultation. In addition the patient is markedly blanched, very restless, has air-hunger, and a rapid, running pulse.

Treatment. This consists in prompt laparotomy and the removal of or suitable treatment for the diseased viscus. This implies accurate diagnosis of the cause of the trouble, which may not be easy, but usually can be arrived at by careful attention to physical signs. Particulars of the signs whereby the various abdominal calamities can be differentiated from each other will be found in the succeeding chapters.

In some cases it will be impossible to diagnose the cause of the peritonitis before operation, and in these cases it is best to operate through a paramedian or transverse subumbilical incision.

In most cases, when the primary cause has been dealt with and any exudate removed by gentle, dry swabbing, every care being taken to disturb the abdominal contents as little as possible, the peritoneal cavity and abdominal wall should be closed in layers and no drainage employed.

Diffuse or generalised acute peritonitis is the more unfavourable and very serious result of failing to diagnose, or neglecting any case of early spreading peritonitis as already described. The inflammation spreads throughout the whole of the greater, and maybe the lesser, peritoneal sacs; there is considerable seropurulent exudate, and death usually supervenes from toxæmia, while in those few cases where recovery ensues, much trouble is likely to occur later as the result of the extensive and usually persistent "adhesions" which will be consequent inevitably on the resolution of so severe and generalised an inflammatory reaction.

Clinically, in late cases, the classical signs of Hippocrates will be seen, but it cannot be emphasised too strongly that these are the signs of impending death from dehydration and toxæmia, rather than, as is so frequently suggested in print, the signs of peritonitis in a stage when hope of recovery may be expected from operative interference.

The abdomen is distended, rigid and board-like throughout the whole abdominal wall, and there is no movement on respiration, which is entirely of the thoracic type and much hampered by the distended bowel pressing up on the diaphragm, unless the patient is supported in the sitting position. In very severe cases, with marked toxæmia, the abdominal muscles may be quite lax, and the temperature normal or subnormal, but the pulse is always rapid. Tenderness is present and generalised, hyperæsthesia being marked; pain is constant and very severe; on auscultation absolute silence is detected, as the bowel is paralysed and distended.

Free fluid may be detected in the flanks on percussion, and the level varies if the patient is rolled on to the side. Free gas may be present sometimes when the liver dulness is obliterated. Obstinate constipation is present, neither fæces nor flatus being passed, and retention of urine is not uncommon.

The facies is pinched and anxious, the eyes sunken, and the face often sweating (*facies Hippocratica*), the mind clear and alert to the end, the patient often failing to appreciate that death is impending. Extreme toxæmia and collapse are present. The tongue and mouth are dry and covered in brown or black sordes; vomiting is present and occurs frequently, small amounts of green or brownish fæculent-smelling liquid being regurgitated and dribbling down the patient's chin—a condition of "fæcal vomiting."

The pulse is weak, rapid and irregular; the temperature may be raised or subnormal.

The patient lies propped up in bed in order that the diaphragmatic movements in respiration may not be hampered by the pressure of the distended and paralysed bowel, but even so respiration is often laboured and panting. Hiccough is often present, and is a distressing and persistent symptom, indicating that the peritoneal infection has spread to the subdiaphragmatic region.

Carphology may be observed not infrequently in the last stages of the disease, when septic diarrhœa may supervene also on the previous obstinate constipation.

The *prognosis* in generalised peritonitis is practically hopeless, the presence of persistent hiccough or a subnormal temperature being of particularly grave significance. As a rule a patient will live only for two or three days after the onset of the signs above described, but in some cases, especially in young adults, great vitality is displayed, and the patient may drag on for a week or ten days before succumbing.

Diagnosis. It is scarcely possible to misdiagnose a case of generalised peritonitis if the patient be merely glanced at, and quite impossible if a careful examination be made. The history of inability to pass fæces or flatus may lead to a diagnosis of intestinal obstruction, but the vomiting in obstruction is projectile, while in peritonitis a mere regurgitation occurs. The old saw that " a man with obstruction of the bowel vomits over the sheets, whereas a man with inflammation of the bowels (peritonitis) vomits down his chin and shirt," aptly sums up the position. Acute obstruction may have preceded the peritonitis, although once general infection of the peritoneum is established it is often impossible to ascertain the original cause. As already mentioned, the general toxic condition of the patient closely resembles that seen in gas gangrene, but the presence of abdominal symptoms and the frequent fæcal vomiting will prevent any misdiagnosis.

Treatment. (*a*) In the earlier stages two distinct types of case may be seen, which are of importance in both their ætiology and consequent treatment. If a favourable result is to be hoped for, early recognition and prompt treatment of peritonitis are essential. There is marked abdominal distension with rigidity and tenderness, and absence of peristalsis in both types, though in the early stages this will be more marked in the region of the causative viscus. Vomiting is of late onset in these cases.

(i.) The patient is restless, mentally alert and often brilliant, the tongue is clean or comparatively so, and the pulse is rapid, irregular and running.

(ii.) The patient lies quiet, is lethargic though conscious, and has a brown, furred tongue and foul breath, with a pulse rapid but full and bounding. Vomiting is early in commencement and often copious.

In both types the primary focus must be removed promptly.

In type (i.) prompt administration of B. welchii serum—80 units concentrated intramuscularly and 40 units daily till the distension subsides and the bowels open—usually in about four days—is frequently successful, provided the primary inflammatory focus has been removed. This acts by neutralising the toxins of the B. welchii abnormally present in the small bowel as a result of the stagnation and decomposition of the contents.

In type (ii.) the patient's vomit should be collected and administered per rectum through a high rectal tube in quantities of from 4 to 8 ounces, at about four-hourly intervals till the bowels act or flatus is passed freely. Alternatively, a high enema of fresh ox bile (or, better, human bile) may be administered, but this is not so efficacious as the patient's own biliary and pancreatic secretions, the absence of which from the bowel may be a potent cause of paralytic ileus.

Gum or saline infusion or blood transfusion may with advantage be practised immediately before or during the operation, and subsequent to this continuous intravenous drip gum saline with 10 per cent. glucose or rectal saline may be given. The introduction of a stomach tube through the nose and its connection to a suction apparatus, by mechanically emptying the stomach of fluid, gives great comfort to the patient and relieves him of the exhausting efforts of vomiting. Morphia should be given freely and in large doses.

(*b*) Late in the disease treatment is usually of little avail, but laparotomy, with removal of the original cause of the inflammation, offers the best chance of recovery, and should be undertaken promptly in all but the obviously moribund cases. Drip-infusion, duodenal suction and morphia must of course be used subsequently.

The abdomen is best opened by a free paramedian incision made under nitrous oxide and oxygen or local anæsthesia, and the cause of the trouble is rapidly sought for and dealt with, but it must be remembered that the patient is in no condition to stand an extensive or prolonged operation. Free fluid is gently and thoroughly sponged out with dry sterile swabs, the bowels being disturbed as little as may be, and the abdomen closed. Many surgeons employ drainage of the peritoneal cavity by rubber or gauze cigarette drains, if there appears to be tension so that pus flows out, on the grounds that relief of the tension gives an increased blood supply, but we are not in favour of this, and believe in completely closing the peritoneal cavity. Drainage would not appear to give the patient any better chance of recovery than closure, for :—

(*a*) The drainage tube is patent for only forty-eight hours before becoming occluded with omentum and exudate.

(*b*) During that period such exudate as escapes can be shown to be far richer in antibodies and leucocytes than in toxins and micro-organisms.

(*c*) This absence of free drainage is rather to be expected, as the tubes are draining uphill from the surface of the fluid, and mainly as a result of the pressure of the surrounding viscera.

(*d*) It can be shown that secondary infection occurs down the tubes in some cases.

(*e*) Where recovery ensues " residual abscess " is as common in drained as in undrained cases.

A jejunostomy may be performed and the bowel washed out with warm sterile saline theoretically with advantage, for it may relieve some of the distension, toxæmia and vomiting, besides apparently improving the chances of recovery ; possibly this is because the B. welchii (or other) toxins are drained away from this region of the bowel where the organism is not usually present unless obstruction has occurred, and whence the toxin is rapidly absorbed and the gut wall poisoned and paralysed. This procedure, however, practically never does any good as a secondary operation in cases of post-operative peritonitis or paralytic ileus, and the more experienced a surgeon is, the less often does he perform such a jejunostomy.

The patient should be supported in the " Fowler " position, more because this relieves respiratory embarrassment and so renders the case more comfortable than because the effusion is thereby drained to the pelvis and toxic absorption lessened thereby.

Attempts at purgation are by most surgeons thought to be useless and inadvisable, as the vomiting is thereby increased ; similarly enemata are often retained or returned as clear fluid from the empty rectum. Enemata of the patient's own bilious vomit or fresh human bile may be given, two ounces per rectum with two ounces of saline as advocated on p. 538, or acetyl-choline injected, or B. welchii serum administered. In some cases, especially where the tongue is very dry and furred (just those where antigas serum so often fails), the bowels will act and recovery ensue if the first is done.

After operation, should purgation be believed in, pituitrin, 1 c.c., or eserine sulphate, gr. $\frac{1}{60}$, may be given four-hourly, or calomel, gr. $\frac{1}{8}$, given two-hourly for ten doses, in order to endeavour to restore peristalsis in the paralysed bowel wall, and should these produce any relief, much assistance may be afforded by giving an enema of soap and water, one pint, to which ʒij of fresh or grs. xxx of dried ox bile have been added, or a glycerine enema, ʒij. Prostigmine, 3 c.c., will sometimes succeed when all else has failed.

Morphia must be given for the pain, and this may be combined with atropine sulphate, gr. $\frac{1}{100}$, to counteract any possible paralysis of the bowel musculature ; in the last stages of the disease morphia must be given freely and in large doses, and many surgeons consider this the best treatment in much earlier stages of peritonitis, as it ensures rest not only to the bowel but to the patient. Sulphanilamides are beneficial in suitable cases.

Hiccough is a distressing symptom of grave significance, and but little can be done for its relief in these cases. Morphia is the most successful drug, but ether, ♏x or Tinct. iodin., ♏ij, may be given in water for three doses, or Tinct. chloroformi et morphinæ co., ♏x, for four doses at half-hourly intervals; both these, however, are liable to be vomited when peritonitis is present.

Localised acute peritonitis frequently results from similar infections, for as already pointed out there is a great tendency for the formation of adhesions between inflamed peritoneal surfaces. Thus the infection tends to be localised by the formation of adhesions between adjacent coils of bowel, and by the presence of the great omentum which enfolds and forms a matted wall around any inflamed viscus it can reach. Localisation is usually well established in forty-eight hours from the onset of infection. In favourable cases the infection will be overcome, the fibroserous exudate reabsorbed, and conditions return to normal in a few weeks. In the majority of cases, however, suppuration occurs, the pus being contained between the adherent intestinal coils and omentum, and so limited to the region of the infected and often partially gangrenous organ, with the resultant formation of a *localised intra-peritoneal abscess ;* in this case resolution is slow, and adhesions persist for from two to three months, or even longer.

Care must be taken that violent palpation or the administration of purgatives and enemata is avoided, for the adhesions often will be broken down by violent or strong peristalsis, and the localisation thus ended, with resultant generalisation of the peritonitis. Occasionally a similar diffusion may result from increase of virulence of the infection.

Clinically, the preliminary stage of peritonitis remains localised to the area first affected, and in about forty-eight hours from the onset of the inflammation the rest of the abdomen loses, to a great extent, its tenderness and rigidity, and respiratory movements may be noted except over the inflamed area. Pain and tenderness persist, but are localised to the affected area, and the pain often alters in character, becoming throbbing. Frequently a mass may be felt on palpation, and it is always obvious under anæsthesia when the muscular rigidity has vanished ; if situated low down in the abdomen or in the pelvis, the mass can be detected often on rectal or vaginal examination, and gentle bimanual manipulation often will elicit fluctuation. Percussion may reveal dulness if the abscess is directly attached to the abdominal wall, but the note will be resonant in all cases where bowel lies between the abscess and the abdominal wall.

Auscultation reveals peristalsis in those segments of the abdomen where no peritonitis exists, but nothing can be heard in the region of the localised mass.

Where the abscess is actually pointing, œdema and redness may be observed in the abdominal parietes ; usually this is of the anterior wall, but occasionally in the loin, and especially above the pelvic crest through Petit's triangle. The abscess may point into any hollow viscus, when œdema of the wall, which feels hot and dry, can be detected in those regions where digital palpation is possible, *i.e.*, the rectum and vagina.

The general condition of the patient improves when the peritonitis localises, and although the temperature remains raised, the pulse rate steadies and slowly drops. The tongue remains furred and the breath fœtid, constipation persists, but flatus may be voided, and vomiting, if it has been present, ceases. Marked leucocytosis is present if suppuration has occurred.

Prognosis. As already indicated, it is not till within thirty-six to forty-eight hours from the onset of peritoneal infection that it can be known certainly whether the resultant peritonitis will localise or diffuse and become general, hence the axiom—*always remove an inflamed viscus if seen within forty-eight hours of the onset of infection.* Once localisation has occurred, then the prognosis is good, as in only a small proportion of cases does the infection diffuse once it has been localised by peritoneal adhesions ; so that if the case can be observed it is better to watch it for a time if localisation, as indicated by a palpable mass and falling pulse rate, has occurred, for it has been shown that a mortality of 25 per cent. results from opening abscesses across the peritoneal cavity, even when every precaution is taken to shut this off (see also pp. 512, 715).

Differential Diagnosis. It may be difficult to determine if localisation is present in any case of peritoneal inflammation. In the first forty-eight hours after infection it is, as already stated, impossible to prognosticate whether the infection will be localised or not, and thus removal of the diseased organ is indicated in all cases seen within that period.

After this time, if the signs are localised, the temperature raised, the pulse falling, localised rigidity present, and the patient fairly comfortable, the case is localising, but an increasing pulse rate, falling temperature, or sudden loss of pain and increase of muscular rigidity call for instant operation, as the peritonitis is becoming diffuse.

Treatment. Provided it is certain localisation has occurred and the abscess is not " pointing " at any part of the abdominal parietes, a localised peritonitis is most safely treated by keeping the patient in bed under observation.

Purgation or enemata *must be avoided* because of the very real danger of breaking down adhesions, and patients take no harm if the bowels are left unopened a week or ten days ; a natural action will occur in the end, or if the patient by this time is very uncomfortable, a small glycerine enema will produce a result.

The patient may be left in any position which is most comfortable, as once localisation has occurred the " Fowler " position loses its value in preventing absorption. Pain usually may be relieved by local application of heat, *i.e.*, hot rubber bottles, hot pads or stupes, and if necessary, by giving a sedative, either potassium bromide and aspirin, āā. grs. x, or Pulv. Ipecac. Co., grs. x, or if no doubt exists that localisation has occurred, morphia, gr. ¼, may be given safely.

The diet must be light, but too much fluid should be avoided, as flatulence will result from an excessive use of " slops."

Should the patient be unable to be under observation, many surgeons consider it safer to perform "cœliotomy," as there is, as already stated, a slight risk that the infection, although localised, may yet spread and become generalised.

Cœliotomy consists in opening the abdomen over the region of the mass, and leaving a rubber drain down to the wall of this across the peritoneal cavity. The matted mass of bowel and omentum must not be disturbed, or infection will be diffused. This operation, which is usually followed by a rapid fall in temperature and pulse, saves all risk of infecting the general peritoneal cavity, and yet forms a track along which pus will point should resolution fail to occur.

Should the abscess be adherent to the abdominal parietes, an incision must be made through the dull area, the pus evacuated, and a rubber drain inserted; no attempt should be made to identify the inflamed viscus.

After any of these lines of treatment, when an interval of two or three months has elapsed in order to allow peritoneal conditions to return to normal, it is advisable to operate for the purpose of ascertaining and dealing with, if possible by excision, the viscus which was the primary source of infection.

Should the abscess be about to burst into any hollow viscera, such as the rectum or vagina, it may be encouraged to do so by hot douches, or the wall be incised over the most prominent part of the bulge and the pus evacuated. (See also acute appendicitis, pp. 713, 715.)

INTRAPERITONEAL ABSCESS

Intraperitoneal abscess may occur in any situation, but is most commonly met with :—

(*a*) In the *pelvis* secondary to appendicitis and disease of the Fallopian tubes, or from pus gravitated there after adoption of the "Fowler" position in any peritoneal infection.

(*b*) In the *right iliac fossa* after appendicitis, when also the abscess may be met with on the left side.

(*c*) *Beneath the diaphragm* after perforation of gastric or duodenal ulcer, phlegmonous gastritis, appendicitis, or secondary to pleural suppuration which has spread through the diaphragm. Such abscesses are spoken of as *subphrenic*.

(*a*) **A Pelvic abscess** usually follows inflammation of the Fallopian tubes, attempted abortion when the pouch of Douglas is infected through the perforated posterior vaginal fornix, or puerperal uterine sepsis, in the female, or infection from a pelvic appendix in either sex.

Clinically, the abscess forms a tender mass occupying the pelvic cavity, and may be felt above the pubes if large. Rectal or vaginal examination will reveal the mass bulging into the lumen, while the wall can be felt thickened, and the cavity feels hot and dry instead of warm and moist. Tenesmus, with frequent passage of mucus, or vaginal discharge, will indicate where the abscess is pointing.

There may be difficulty in micturition owing to pressure on the urethra, but more often there is frequency from irritation of the bladder secondary to the pressure upon and involvement of its wall; pyuria may be present. Constipation is present, the tongue brown and furred, and the temperature raised.

Prognosis. The abscess usually subsides or bursts into the rectum, or more rarely into the thick-walled vagina; occasionally the pus is evacuated into the bladder; occasionally the infection spreads into the general abdominal cavity owing to breaking down of the matted mass of intestine and omentum which forms its upper wall, and general peritonitis then results.

The *treatment* (p. 541) consists in giving hot rectal washouts or vaginal douches which relieve pain and local discomfort, and tend to make the abscess burst more rapidly. Such an abscess often can be opened into the vagina or rectum with advantage when pointing there: it must be clearly understood that for this to be wise the abscess must be definitely pointing there and not merely palpable. This is usually shown by œdema of the mucous membrane and may take several days to achieve. Purges and enemata should be avoided as tending to break down adhesions. Should generalised peritonitis occur, laparotomy is indicated.

(*b*) **Abscess in the right iliac fossa** is nearly always retrocæcal or secondary to appendicitis, but it may follow renal infection or spread up from the broad ligament in the female; very occasionally it is secondary to suppuration in the glands along the external iliac vessels, or to acute osteitis of the ilium.

The condition calls for no special description, and the treatment is as indicated on p. 715.

(*c*) **A subphrenic abscess** is nearly always secondary to perforation of a gastric or duodenal ulcer, and is therefore more common on the right side, but it also follows cholecystitis, appendicitis, injuries of the liver and spleen, rupture of a hepatic abscess, or extension of an empyema through the diaphragm. The pus may be situated above the liver, when it will be either to the right or left of the falciform and coronary ligaments, or it may be subhepatic, when the abscess lies usually in the greater sac of the peritoneum; it, however, may be found in the lesser sac, and is then behind the stomach, but in either case is above the transverse mesocolon. When secondary to liver abscess, the subphrenic suppuration is often between the layers of the coronary ligaments, *i.e.*, between the "bare area" and the diaphragm, and therefore extra-peritoneal.

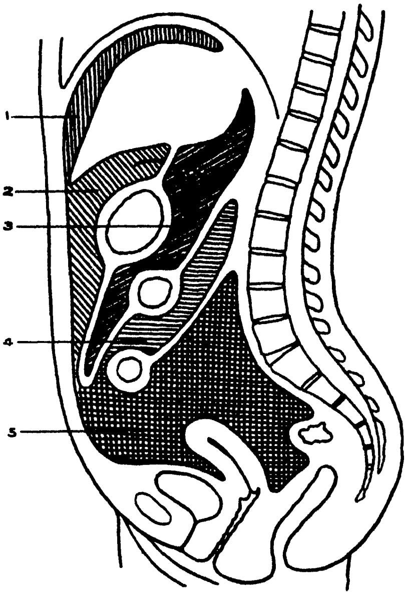


FIG. 192. Diagram of the main peritoneal pouches. 1. Subphrenic pouch. 2. Subhepatic pouch communicating through the foramen of Winslow (arrow) with 3. The lesser sac. 4. Pouch below the transverse mesocolon. 5. Pouch below the mesentery continuous with the pelvic cavity. The renal

Clinically there may be obvious swelling and œdema in the epigastrium following an attack of peritonitis, but often no such signs are visible, though the upper abdomen moves badly on respiration and the recti are rigid in this region. Dulness can be detected in the epigastrium on percussion and the normal area of liver dulness is increased, unless gas is present in the abscesses, when there may be partial obliteration of liver dulness with a hyper-resonant note at the highest point as the patient is lying. If the abscess is above the liver, the liver edge may be palpable. Auscultation shows absence of breath sounds in the lower lobe of the lung on the affected side, or crepitations and prolonged expiration if the lung is still moving; these signs are due to a slight degree of collapse of the lung.

An X-ray examination shows that the diaphragm is motionless and raised on the affected side, often very considerably. The heart may be displaced upwards, but never laterally as in empyema.

There will be general signs of toxæmia, such as raised pulse and temperature, furred tongue and leucocytosis, while owing to the situation of the abscess, pain may be referred to the shoulder of the affected side.

The *prognosis* is often grave, as the condition is liable to escape notice and may not be diagnosed till the patient is wasted and toxic; while even if treated early by operation there is a risk of further peritoneal infection or pyæmia or pylephlebitis occurring. If left to itself the abscess may burst into the stomach or colon, point through the abdominal wall, spread through the diaphragm and cause empyema, or cause death from pyæmia or suppurative pylephlebitis.

The *diagnosis* is by no means easy, as the pus is far from the surface in a region normally dull on percussion. The persistence of a hectic temperature, rapid pulse, and signs of toxæmia in any case of peritoneal infection should lead to the suspicion of intraperitoneal suppuration, and if a mass cannot be found in the pelvis or elsewhere, subphrenic abscess should be suspected and sought for. Even when obvious signs are present in the upper abdomen and lower thoracic regions it may be very difficult to make up one's mind if the pus is situated above or below the diaphragm.

The most certain way of diagnosing between *empyema* and *subphrenic abscess* is by noting, both by physical signs and X-ray examination, whether the heart is laterally displaced or not; lateral displacement occurs in empyema, and pure upward displacement in left subphrenic abscess. Moreover, in X-ray negatives the convex upwardly displaced dome of the diaphragm is seen in a subphrenic abscess, whereas in empyema the diaphragm is level and the upper limit of the shadow of the fluid horizontal.

Liver abscess may cause great difficulty in diagnosis, but here the wasted earthy appearance of the patient, the long history, or the possible presence of amœba hystolitica in the stools, should establish the diagnosis, though it must be remembered that the abscess may burst and cause a subphrenic abscess (Chapter XVIII., p. 737).

Suppurative pylephlebitis also may cause trouble as the liver is enlarged and tender, and the condition follows abdominal inflammation, but the persistent rigors and sweats and the frequent jaundiced condition of the patient should make the diagnosis clear (Chapter XVIII., p. 736).

Treatment. Aspiration should be avoided as a rule, as apart from the danger of infecting the pleural cavity across which aspiration is performed through one of the lower intercostal spaces, there is grave risk of damaging the stomach, liver, or spleen.

If, however, doubt exists as to whether an empyema or subphrenic abscess is present, the pleural cavity may be explored with a needle and syringe to see if pus be present in it.

The abscess is best opened by removing a portion of the ninth or tenth rib in the midaxillary line, and incising the diaphragm across the usually obliterated pleural space in the phrenicocostal angle, or by performing the operation a little lower the pleura may be avoided altogether and the diaphragm incised below it. The pus is then usually easily evacuated and a tube inserted. Should no pus be found a tube can be inserted among the adhesions, when the abscess usually discharges in a day or so.

If the abscess is pointing at the abdominal wall it should be opened there, but a transpleural counter-opening is often necessary.

CHRONIC PERITONITIS

Chronic peritonitis is nearly always tuberculous, but occasionally may be gummatous, pyogenic, or due to streptothrix infection. The resultant inflammation may be localised or generalised.

Chronic aseptic peritonitis is uncommon and occurs only when a *sterile foreign body is left in the peritoneal cavity,* usually after operations. An inflammatory reaction occurs, as in any tissue, with the object of surrounding the body with a fibrous capsule, which in the case of an intraperitoneal reaction involves surrounding the body with omentum and adherent bowel, so that symptoms of intestinal obstruction are not uncommon. As a result of the stasis in the bowel secondary infection of the area often occurs, an abscess forms and may point into the bowel or on the abdominal parietes; when this bursts or is opened by the surgeon, the retained foreign body, usually a gauze swab or instrument, is partially or gradually extruded, either into the bowel or through the sinus in the abdominal wall. In some cases, where the body is deep in the peritoneal cavity, a chronically discharging sinus, lined with granulations, may result, or even a fæcal fistula (p. 675).

Chronic peritonitis of infective origin is, as already stated, usually tuberculous, but may arise from other causes, and may be generalised or localised.

The onset is usually gradual, but may follow a definite attack of acute infection, usually secondary to an inflamed viscus.

(1) **Chronic Generalised Peritonitis.** *Clinically,* the abdomen is usually slightly distended, and there is a history of vague and constant abdominal discomfort and chronic constipation, culminating at intervals with exacerbations of colicky pain, with vomiting and signs of acute obstruction of the intestine. Visible peristalsis may be seen often, the more readily as the patients are usually thin and anæmic, the skin having a peculiar dirty, earthy appearance.

The abdomen on palpation feels characteristically flabby and "doughy," the fingers sinking in and meeting a soft resistance as in dough; often masses may be felt, and the omentum is especially liable to be rolled into a transverse ridge lying above the umbilicus. Tenderness may be present, but is seldom marked. Fluid may be detected in the flanks, the level shifting with the position of the patient, or it may be localised by adhesions. On auscultation irregular peristalsis may be detected in some regions, but often nothing abnormal can be heard unless an acute attack of obstruction is present.

If acute obstruction is present or threatened, the signs will be typical of this condition (Chapter XVI., p. 676), but it is to be noted that such attacks often subside, though usually ultimately one is fatal unless operation is undertaken for its relief.

Pathology. When the abdomen is opened the whole peritoneum is seen to be thickened and often gelatinous in appearance, fluid of a serous character is usually present to a greater or less extent, and may be loculated. The bowels in bad cases are in a matted mass and adherent to the posterior abdominal wall, so that the whole peritoneal cavity presents an appearance suggestive of the bowel being preserved in aspic. The lumen of the bowel is often irregular, some coils being distended and others contracted and thickened.

In less severe cases the bowel coils, though adherent to each other, are not bound back, or they may be nearly normal in appearance and a few long strands of adhesions be present.

The omentum is usually very thickened and contracted, forming a thickened and transverse ridge in the epigastric regions, from which elongated processes are often adherent to coils of bowel or the parietal peritoneum.

The mesenteric lymph nodes are frequently enlarged.

(2) **Chronic Localised Peritonitis.** *Clinically,* a localised and often tender mass is found in the abdomen of a patient who usually complains of abdominal pain; this often results from previous acute inflammation (p. 534), but may come on insidiously, in which cases chronic infection presumably occurs from the bowel. The mass is most usually situated in the right iliac fossa, and may be dull or resonant on percussion. Irregular peristalsis is generally audible over the area of the mass. The patients are usually ill and wasted, and often complain of abdominal pain, but attacks of obstruction are uncommon.

Pathology. A localised mass is present, consisting of matted bowel and usually the free end of the omentum, the peritoneum being thickened and dull, and often grey and translucent. The proximal portion of the bowel is frequently distended from chronic obstruction.

Diagnosis. Generalised infection is usually easily diagnosed, but localised masses may be mistaken for carcinoma, actinomycosis, or hyperplastic tuberculosis of the bowel, while diverticulitis may cause trouble if the mass be on the left side; all these conditions are accompanied by considerable local peritonitis. Malignant invasion of the peritoneum may be almost impossible of differentiation.

The *treatment* varies somewhat with the ætiological organism, but in any case where obstruction is present immediate laparotomy is indicated, the actual treatment to relieve the obstruction being determined by the conditions found; division of peritoneal bands, separation of adhesions, anastomosis of coils of intestine, or resection and anastomosis may be necessary. Colostomy cannot be performed often, as the obstruction is most frequently in the small intestine.

If no obstruction be present, treatment by X-rays, abdominal massage, ultra-violet rays and sun treatment may be tried, and are often of benefit, while constipation may be treated by mild aperients, of which liquid paraffin or cod-liver oil are very beneficial, as the latter also fattens the patient.

SPECIFIC PERITONEAL INFECTIONS

Such infections rarely may occur primarily, but are usually secondary to infection elsewhere in the body; they are either blood-borne, as in septicæmia, or the result of infection of some abdominal viscus, when the secondary peritoneal invasion may be either by direct extension or via the lymphatics. In any infection the resultant inflammatory reaction in the peritoneum may be acute or chronic, some organisms being more prone to produce the one reaction and some the other, as will be indicated in dealing with the various diseases.

It may be emphasised again that the inflammation resulting in the peritoneum is exactly similar to that in any other tissue, the ultimate result being complicated by the fact that the intestinal stasis consequent on the peritonitis produces untoward results in that it often introduces a secondary infection, and thus increases the toxæmia.

Thus mixed infections are very common, the peritoneal exudate containing vast numbers of intestinal bacteria, among which B. coli usually predominates.

Pure infections do occur, however, usually in blood-borne diseases, the pure culture being obtainable only in the early stages of the infection in the majority of cases, as secondary invasion by bowel organisms follows stasis.

Intestinal Infections. (1) *Bacillus coli* is usually present, and produces a white pus, which is quite odourless if the B. coli is present in pure culture ; as, however, many saprophytic and other bacteria are generally present, a peculiar fœtid odour is often associated with the pus found in those cases where secondary bowel infection causes B. coli to be present in large numbers ; hence many surgeons call pus having this odour " B. coli pus," and so the odour has become quite erroneously associated with the presence of B. coli.

(2) *Staphylococcus aureus and albus* are often associated with B. coli in acute infections, and can be recovered in pure culture in many cases of chronic peritonitis, which may be clinically aseptic.

(3) *B. pyocyaneus* is occasionally the chief organism, when the pus has a characteristic blue-green colour. Such patients are always extremely ill, and the infection nearly always terminates fatally.

(4) *B. welchii*, usually only present in wounds or perforations of the colon, is sometimes met with in appendicitis. Where the infection is generalised or free gas is present in the peritoneal cavity, the patient shows all the signs of B. welchii toxæmia, *i.e.*, a clear mental state, rapid pulse and subnormal temperature, and has in addition very severe abdominal pain : he may get a gas infection of the abdominal parietes, starting usually at the abdominal incision or wound, from which an evil-smelling, thin sanious exudate and bubbles of gas may be seen escaping. Such cases are usually rapidly fatal, even in spite of free and early administration of antigas serum. Localised infections are not so generally fatal, and it is not very uncommon to find gas in appendix abscesses, with ultimate recovery. In such a case the mass in the abdomen is resonant on percussion over its highest point, and if sufficiently large the area of resonance can be demonstrated to change with the position of the patient. In such cases the pulse is often unduly rapid, and severe pain is present, the patient sometimes showing signs of severe toxæmia.

Treatment consists in immediate cœliotomy and placing a drain down to the abscess wall, as gas-containing abscesses seldom settle down unless this be done. Occasionally such an abscess may point into the bowel or parietes, but usually it bursts into the peritoneal cavity, a severe and fatal B. welchii infection resulting.

(5) **Streptococcal peritonitis** is usually generalised, and may result either from blood-borne infection in a septicæmia, or follow upon infection from the bowel, or in the female, sepsis in the uterine cavity after parturition or abortion. In bowel infections the short-chain hæmolytic streptococcus fæcalis is often present; such cases are often accompanied by purpuric eruptions and are usually fatal.

Clinically, the patient is usually extremely ill, and presents all the signs of a generalised peritoneal infection, with, in addition, an amount of toxæmia out of proportion to the abdominal signs. In some cases so severe is the general infection that the abdominal muscles are quite relaxed, though the abdomen is distended ; presumably this is due to a toxic paralysis, and the patient may not complain of abdominal pain in these cases.

The pulse in the early stages may not be raised above 85–100, but later becomes very rapid, weak and irregular; the temperature is usually subnormal.

In cases of intestinal infection toxic diarrhœa may be present, and subcutaneous petechiæ or even hæmorrhages are often seen on the abdominal wall and elsewhere.

The *prognosis* is bad, and can be regarded as hopeless if the abdominal muscles are flaccid and pain is absent.

The *treatment* consists in immediate laparotomy where the general condition of the patient permits, with the evacuation of the thin seropurulent fluid from the peritoneal cavity; any local focus is dealt with, and the abdomen swabbed out and closed. Drainage should never be employed. Intravenous drip transfusion is very valuable in these cases.

In cases with a primary streptococcal focus elsewhere this also needs treatment, and the general condition of the patient often may be so serious as to contra-indicate laparotomy, unless the peritoneal symptoms are severe. Sulphanilamides must be given in all cases. Antistreptococcal serum may be injected intramuscularly with benefit in a few cases, its effect very rarely being little short of miraculous. Polyvalent serum is usually the most efficacious, and it must be given in large doses—300–400 c.c.—and repeated daily for three or four days.

The conditions above mentioned may follow wounds or infections from the bowel, the organisms then infecting the peritoneal cavity, either directly or indirectly via the lymphatics, or they may less often be blood-borne from foci elsewhere in the body. It must be remembered, however, that any of these organisms may be liberated from the bowel at operation, and that unless great care is taken that the peritoneum is protected from infection, **post-operative peritonitis** will result. This is often fatal, or followed by the formation of adhesions; it can be avoided only by careful packing off of the peritoneum in any operation where bowel is incised, and by the surgeon and his assistants changing gloves and using new instruments after the bowel is closed and the packing removed.

Pneumococcal peritonitis usually occurs as a blood-borne infection in cases of lobar pneumonia, but may follow otitis media, pharyngitis, or an empyema; occasionally in females, usually small girls, infection may occur via the Fallopian tubes from the uterine cavity or vagina. The disease is most often seen in children, usually of the female sex, and is commonly acute and generalised, though local pneumococcal abscesses may be met with.

Clinically, in the generalised form the child is acutely ill, thin and petulant, and frequently the alæ nasi may be working, even when no signs exist in the lungs. There is at times head retraction and a rigid neck and back due to coexisting pneumococcal meningitis. The abdomen is sometimes retracted in the epigastrium and distended in the lower part, and moves badly on respiration, while palpation reveals generalised tenderness and rigidity, the signs tending to be more marked below the umbilicus. Slight vaginal discharge is often present, and the pneumococcus can be recovered from this. Vomiting is usually present, and in addition diarrhœa is common, which is unusual in other forms of peritonitis. Other foci of infection should be looked for in the lungs, etc., and the pulse-respiration ratio is markedly decreased in many cases.

In the localised variety, after an attack of pneumonia in some cases, the child becomes ill and wasted, and a mass can be detected in the abdomen, usually the lower part of the pelvis; if left it may burst sometimes and cure itself spontaneously.

On opening the abdomen typical odourless, green, pneumococcal pus, containing flakes of lymph, escapes, and from this the pneumococcus can be grown, usually in pure culture.

Prognosis is grave in all cases, and especially so in cases where severe pulmonary lesions exist; in the localised variety recovery often ensues.

The *diagnosis* in either variety is not usually possible until the abdomen is opened and the typical pus observed, but the presence of other lesions in the body, the diarrhœa, and working alæ nasi in acute cases, may render its recognition possible. It is well to bear in mind both that lobar pneumonia often gives rise to reflex pain and rigidity in the abdominal wall, usually in the epigastric region, and also that a child with pneumonia may develop acute appendicitis and subsequent peritonitis.

Treatment. If the diagnosis is certain, or the case mild, the child should be kept at rest in bed and M. and B. 693 and anti-pneumococcal serum administered, or a vaccine given if available. There seems no doubt that cases of pneumococcal peritonitis stand a better chance of recovery if this method of treatment be adopted than if laparotomy be performed.

When, as is often the case, the diagnosis is doubtful, laparotomy must be performed; if the typical pus is discovered the peritoneal cavity must be gently swabbed out with sterile gauze plugs, and the abdominal wall closed without drainage, as the tube tends to give rise to a secondary infection. Anti-pneumococcal serum should be given. Care must be taken in giving intravenous infusion in cases with lung infection.

In localised cases the abscess should be opened, the pus swabbed out, and the abdominal incision closed without drainage. This treatment yields better results than when drainage, with consequent risk of secondary infection, is employed. The pus seldom reaccumulates.

Gonococcal peritonitis, like the pneumococcal form, is almost entirely confined to the female sex, but, unlike it, is a disease mainly of adult women, and may be acute, chronic or more often localised. Infection occurs in women via the uterus and Fallopian tubes, following coitus with an infected male. In small girls it may occur in epidemic form from infection from closets and baths in institutions.

The pus is thick and yellowish white in colour.

The diffuse form is uncommon, and results in dense adhesions throughout the peritoneal cavity, so that it gives rise to severe obstructive symptoms.

Clinical Signs. In the "diffuse" form, which often follows marriage, there is generalised abdominal pain, with a furred tongue, vomiting and constipation. The abdomen is rigid, tender all over, and distended, but the condition usually settles down after a few days in bed, and the bride is convinced she has caught a chill. Later, as adhesions form and obstructive symptoms develop, there is increasing abdominal pain of a dragging and intermittent colicky nature, with increasing constipation, and even obstruction. The woman becomes wasted, peevish, and often a chronic invalid.

In the "localised form" (**pelvic peritonitis**) the signs are confined to the lower abdomen and pelvis; the onset is usually acute some two or three days after coitus, but there may be no acute stage noticed. The woman complains of pain in the lower abdomen, constipation, and soreness of the vulva. The lower abdomen is distended, rigid and tender, and on pelvic examination generalised tenderness is found, but in this early stage no localised mass. A

vaginal discharge is usually present, but only small in amount in the acute stage, and from this gonococci can be recovered.

There is often acute tenderness over the external abdominal ring in this type of " pelvic peritonitis."

In the *chronic localised form*, which may succeed the acute stage or commence insidiously, the patient complains of pelvic pain of a dull aching character, and often of a dragging pain over the sacral region. Examination may show distension of the abdomen above the symphysis pubis, and a mass may be palpable rising out of the pelvis, which is tender on palpation. Pelvic examination reveals a thickened mass, usually in one or other lateral fornix and connected with the Fallopian tube (Chapter XXII., p. 975), but there may be bulging posteriorly in the pouch of Douglas. Chronic constipation is usually present, and more or less yellowish vaginal discharge from which gonococci can be grown.

Prognosis. The disease is seldom fatal, but causes much chronic invalidism among women, as a result of the dragging pain and obstructive phenomena produced by the dense adhesions.

The *diagnosis* is easy if the gonococcus can be found, or a definite history elicited. In the localised pelvic form some difficulty may be found in determining whether the appendix (Chapter XVII., p. 711) or the Fallopian tube (Chapter XXII., p. 975) is the primary source of infection. Careful attention to the physical signs described under these diseases alone can elicit a correct diagnosis, and this is sometimes impossible without laparotomy.

In the generalised variety the mildness of the symptoms in the acute stage will differentiate the condition from other forms of general peritonitis, while in the chronic variety the obstructive signs predominate out of all proportion to the general symptoms of inflammation.

Never diagnose gonorrhœal peritonitis except in female patients.

The *treatment* consists in dealing with the primary source of infection by cleansing and douching the vagina, which latter method also eases the abdominal pain. The bowels should be opened gently and the patient kept at rest in the acute stages. Small warm rectal washouts are useful and comforting. Sulphanilamides should be administered by mouth.

In the chronic stages localised abscesses need drainage, if possible via the vaginal fornix, and the Fallopian tubes often need excision (Chapter XXII., p. 976). But the prognosis, even after laparotomy, is not hopeful, as there is a great tendency for re-formation of dense adhesions with their consequent dragging pelvic pain and chronic obstruction.

TUBERCULOUS PERITONITIS

Tuberculous peritonitis may occur at any age and in any sex, but is seen most commonly in children of from three to ten years old. The infection may be blood-borne from lesions elsewhere in the body, usually pulmonary, or be a lymphatic infection from the bowel, in which case there is usually infection of the mesenteric lymph nodes (p. 557) ; it may occur by direct extension to the peritoneum in intestinal or genito-urinary tuberculosis. In the last connection attention must be drawn to the frequency with which the ovary and Fallopian tube are the primary source of infection in girls (Chapter XXII., p. 976).

Acute tuberculous peritonitis is of rare occurrence, and then only as part of a generalised miliary tuberculosis, when lesions are present in the lungs and pleura, and often the meninges. There is abdominal pain and distension, with diarrhœa, and a hectic temperature; the patient is obviously very ill and wastes steadily. Ascites may be present, with signs of free fluid in the peritoneal cavity.

The *prognosis* is always hopeless, death occurring in from three to six weeks.

The *diagnosis* often presents some difficulty, as owing to the presence of meningeal and pulmonary lesions, combined with the sudden onset of the diarrhœa, such cases are often mistaken for typhoid fever. This error is strengthened by the presence of a palpable spleen, but the absence of rose spots and a consistently negative Widal reaction should prevent mistakes.

The distended and doughy abdomen met with in *Psittacosis* may give rise to difficulty in diagnosis, but the lethargy, dull mental state, persistently high temperature and lung signs, as well as constipation, are sufficient to prevent error.

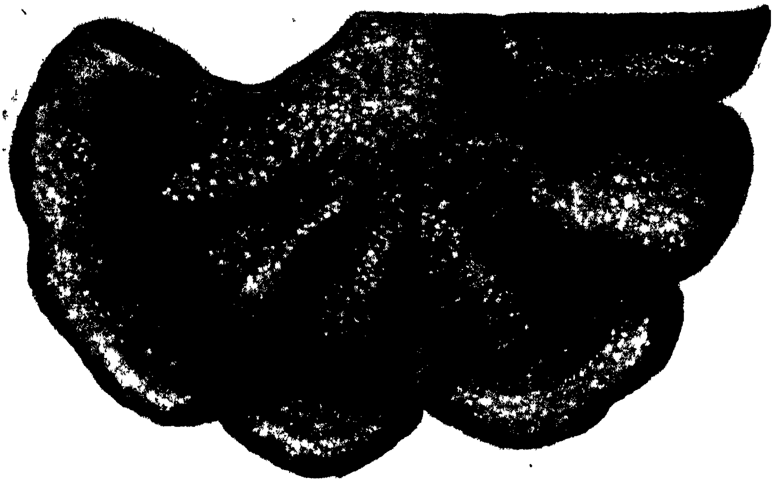


FIG. 193. Tuberculous peritonitis. Coils of small bowel and mesentery studded with miliary tubercles, with some adhesions present.

Pathology. The peritoneum, like the other infected areas, is thickened and gelatinous, and studded with numerous greyish miliary tubercles. Free fluid of a serous nature is often present, the spleen enlarged and soft, and the omentum, which is studded with masses of tubercles, is thickened and often rolled up in the epigastrium. At first sight some difficulty may be experienced in diagnosing the condition from carcinoma of the peritoneum.

Treatment is purely palliative, and surgical measures are to be avoided.

Chronic tuberculous peritonitis is unfortunately all too common, especially among children in towns. The peritoneum is thickened and studded with greyish miliary tubercles, while the omentum is thickened and contracted into a transverse ridge above the umbilicus. The lesions are usually generalised, but may be localised. Peritoneal adhesions are common in one variety (fibrous tuberculous peritonitis), while a copious exudation of serous fluid is frequent in another (tuberculous ascites); pus formation is rare.

Secondary infection from bowel organisms is liable to occur, especially in the fibrous form, where adhesions cause chronic obstruction, and then the condition becomes one of acute peritonitis, and is usually fatal.

Two chief varieties are met with: (*a*) the common form, with free exudation of fluid, which may be generalised or localised; (*b*) the rarer fibrous form (dry tuberculosis), where dense matted adhesions glue the coils of bowel together and there is little or no fluid exudate.

(*a*) **Tuberculous Peritonitis with Effusion.** In nearly all cases the exudate is serous, and consists of a clear, straw-coloured fluid, which may be present in large amounts, and which if injected into a guinea-pig will produce tuberculous lesions; it can be shown to contain small lymphocytes in fair numbers.

The clinical signs vary greatly according to whether the disease is generalised or localised.

(1) *Generalised tuberculous ascites* usually occurs in children or young adults, and there is often a tuberculous lesion elsewhere.

Clinically, the abdomen is greatly distended, the skin over it shiny and tense, and usually showing much blue veining. The patient is much wasted and rather miserable, and the " pot belly " shows in marked contrast to the wasted limbs. On palpation the abdomen has a characteristic heavy, doughy feel, and on " dipping " the fingers in, masses can be felt, especially the transverse omental ridge in the epigastrium. The masses consist of glands and thickened and matted coils of bowel and omentum.

Pelvic examination also may reveal masses, especially in female children, where the tubes and ovaries often constitute the primary focus of disease. Percussion yields a tympanitic note around the umbilicus and a dull one in the flanks in most cases, the level of the dulness shifting with the patient's position. Where much free fluid is present the whole abdomen may be dull, and a " fluid thrill " obtainable (p. 556). There is a hectic temperature, dirty tongue, and a history of vague abdominal pain, with alternating attacks of diarrhœa and constipation.

In males, if the processus vaginalis be patent, a " congenital hydrocele " may be present, and the peritoneum of the vaginal process is studded with tubercles (Chapter XXI., p. 951).

An X-ray film may confirm the diagnosis by showing calcified mesenteric glands to be present (p. 558).

The *prognosis* in this ascitic type of tuberculosis is fair, recovery is the rule, and unless subsequent trouble arises from intestinal obstruction by bands or adhesions, such patients seldom have any lasting symptoms.

The *diagnosis* is usually easy in children, where retroperitoneal sarcoma is alone likely to cause error, and here the extreme pallor of the child is usually sufficient to prevent misdiagnosis. In adults, however, and occasionally in very young children, ascites from hepatic cirrhosis or carcinomatous peritonitis are likely to cause trouble in diagnosis; in many cases this can be elucidated only by laparotomy, especially in malignant cases, where microscopy may be needed in some instances.

The *treatment* consists in laparotomy to allow escape of the fluid, excess of which must be sponged away. Thereafter rapid and marked improvement occurs in both the local and general condition of the patient, presumably because the alteration in tension allows the local infection to be dealt with.

In addition careful attention to the bowels, diet and hygiene are essential; cod-liver oil and exposure of the body, especially the abdomen, naked to the sun or ultra-violet rays are very beneficial in hastening convalescence.

Tapping is a dangerous practice and should be avoided, as a fæcal fistula is very liable to follow.

(2) *Localised or encysted tuberculous ascites* is usually met with in adults, frequently women, where a diagnosis of ovarian cyst is often erroneously made.

The peritoneum usually is healthy, apart from the affected area, which presents as a matted mass of bowel and omentum, with its surface often very thickened and studded with miliary tubercles.

Clinically an otherwise healthy individual usually complains of vague abdominal pain, and on examination a rounded mass can be felt usually in the lower abdomen. The percussion note over the tumour is resonant, even if it be adherent to the abdominal wall. Rarely more than one loculus may be present, or several masses felt.

Diagnosis. As already stated, the condition is likely to be confused with ovarian cyst in the female; in both sexes omental, mesenteric or hydatid cysts closely resemble encysted tuberculosis.

The *treatment* is always operative, the abdomen being opened, the mass packed off and explored, adhesions separated and the fluid allowed to escape. Care must be taken that adherent bowel is not incised when opening the peritoneum, and some help may be afforded by the presence of thickening in this membrane if the bowel is attached subjacently.

Drainage should never be employed, as fistulæ tend to form.

Tuberculous peritonitis with purulent effusion is uncommon, unless secondary infection has occurred, but true tuberculous pus is occasionally met with, especially in young girls, secondary to primary disease of the ovary and tubes. Unlike the serous form of tuberculosis, the purulent form usually runs an acute course, and miliary tubercles are seldom visible in the very thickened gelatinous peritoneum. The pus is not white and flaky, as in tuberculous lesions elsewhere, but thick and greenish-yellow, much resembling pea soup in appearance. If untreated the abscess may burst, usually at the umbilicus, when a fæcal fistula generally results.

Clinically the child complains of abdominal pain and often diarrhœa, looks ill, wastes rapidly, and is flushed and peevish. The tongue is dirty, and there is a hectic temperature; a vaginal discharge may be present in female children, from which tubercle bacilli may be recovered.

The abdomen is thin and usually distended, frequently more in one part than another. Often dulness may be elicited over the most prominent part of the swelling, which can be felt as a large, irregular, but fairly well-defined mass.

The *prognosis* is not so good as in cases with serous effusion, but prompt operation often effects a cure.

Diagnosis. The only condition likely to cause error in diagnosis is a large chronic pyogenic abscess such as occurs occasionally, usually after appendicitis (Chapter XVII., p. 712). Here the child is wasted, and there may be a hectic temperature, but there is no flushing of the face, the child being usually markedly anæmic.

The *treatment* consists in prompt laparotomy, with evacuation of the thick greenish pus, and, if possible, removal of the affected ovary and tube.

The abdominal wall is closed without drainage.

(*b*) **Fibrous and dry tuberculous peritonitis** is not very common, there being dense adhesions of the peritoneal surfaces, so that the whole abdominal contents are matted in a dense and inextricable mass. There is usually no obvious exudate, though a little fluid may collect sometimes between the adhesions. Tubercles can be detected usually, but are not numerous to the naked eye. Fistulæ between coils of bowel, bowel and bladder, or fæcal fistulæ in the parietes are not uncommon.

Clinically there is often a history of progressive wasting and increasing abdominal pain and constipation, terminating in an attack of intestinal obstruction. The abdomen is not much distended, and moves on respiration, there is little tenderness on palpation, but a resistant, somewhat doughy feel. Irregular hard masses may be felt through the abdominal wall and on pelvic examination, and the omentum usually forms a prominent transverse ridge across the epigastrium. Occasionally small dull areas may be detected on percussion, which do not vary with the position of the patient; these are due to encysted fluid just beneath the parietal peritoneum.

The *prognosis* is most unfavourable, the cases usually going steadily downhill and dying either from obstruction or generalised tuberculosis; in the most favourable cases fæcal fistulæ generally develop, and amyloid disease often supervenes.

The *diagnosis* is by no means easy unless definite masses can be detected, or tuberculous lesions exist elsewhere, though the presence of a "doughy" abdomen, with wasting and constipation, is most often due to fibrous tuberculosis. Gonorrhœal peritonitis also causes similar symptoms and dense fibrous adhesions, but here the patients are usually female and adults, while matting and contraction of the omentum to form a palpable ridge is very rare.

Chronic peritonitis due to other organisms is uncommon, but staphylococcal or actinomycotic infections may simulate tuberculosis closely.

Microscopic examination of the exudate and sections of adhesions will establish a diagnosis by revealing the causative bacteria.

Treatment. No surgical interference should be undertaken in fibrous peritoneal tuberculosis if it can be avoided, as the results are usually most unsatisfactory. Only if obstruction exists should laparotomy be undertaken, and then with diffidence, as the dense adhesions make the intestinal loops difficult to free, and the risk of opening bowel is great (see p. 665).

Ultra-violet rays and X-rays, or, better, real heliotherapy, are often of benefit, and cod-liver oil may be given with advantage.

Gummatous peritonitis occurs usually in adults, but may be met with in children with congenital syphilis. There is dense thickening of the peritoneum and ascites, the changes being most marked on and around the liver. There is often pain, and may be jaundice. The Wassermann is positive.

The treatment of the condition is medical, the symptoms yielding readily to antisyphilitic remedies.

Actinomycosis of the peritoneum is always secondary to a bowel infection, usually in the cæcum or appendix, but occasionally invasion in the epigastrium may occur from the pleura, following pulmonary infection. Multiple sinuses soon appear in the abdominal wall, which is indurated, and fæcal fistulæ often develop. The peritoneum is thickened and matted, with multiple small foci of yellowish pus. The typical granules can be recovered from this and from the sinuses (Ch. VI., Vol. I.). Radium or deep X-ray therapy offers the only chance of a cure and massive dosage is often successful. Sulphanilamides have recently been used and amelioration resulted.

TUMOURS OF THE PERITONEUM AND RETROPERITONEAL TISSUES

Simple connective tissue tumours occur in the subperitoneal connective tissue, and may reach a considerable size behind the peritoneal cavity. They are, however, rare, and are seldom diagnosed apart from operation, when they may be found on the bowel or behind the parietal peritoneum.

Lipoma, myxoma, and *angioma* are the types usually met with; *fibroma* is rare, and liable to be confused with fibromatosis in an old retroperitoneal hæmatoma.

Malignant connective tissue tumours (sarcomata) also occur, usually in the retroperitoneal region in children or young adults. The patient becomes emaciated and anæmic, and complains of severe and increasing abdominal pain; sudden collapse from hæmorrhage into the growth or peritoneal cavity is not uncommon, and frequently fatal.

A large, soft mass can be felt in the abdomen, which does not move with respiration, and may fluctuate.

Treatment consists in exploration to confirm the diagnosis, and possibly the insertion of radium or use of deep X-ray therapy.

The *prognosis* is hopeless, and pain can be relieved only by morphia. Should obstruction of the bowel occur in pelvic growths, relief may be afforded by aspiration if hæmorrhage has occurred into the neoplasm, or otherwise by colostomy.

Carcinoma of the peritoneum is rarely primary, being usually secondary to neoplasms of the stomach, colon, or female genital organs.

The peritoneum is usually covered with a gelatinous, often colloid, mass of nodules, and much resembles in appearance barnacle-covered groynes on a beach. Ascites is invariably present, and may be blood-stained; the fluid usually contains enough cells to enable a diagnosis to be made on microscopic examination.

Clinically there are usually signs pointing to a primary focus. There are wasting, and marked cachexia in most cases, the abdomen being distended, while masses can be palpated both through the abdominal wall and on pelvic examination; the liver is often felt enlarged and nodular on " dipping " through the fluid.

Free fluid is always present, and can be detected on percussion, yielding a dull note, which varies in level with the position of the patient. Nodules may be present in the skin or around the umbilicus, while de Morgan's spots are often present.

The *prognosis* is hopeless, the patient usually dying in a few months after the condition is diagnosed; some cases last for a year or two.

The *diagnosis* is from other forms of ascites (p. 556), especially tuberculosis with serous effusion.

Treatment. Relief may be afforded by " tapping " and drawing off the fluid, which rapidly reaccumulates, or by laparotomy, when, however, death often occurs in a few days. Injections of such substances as colloidal cuprase may possibly prolong life, and of adrenalin may prevent such rapid reaccumulation of ascitic fluid. Deep X-rays often produce a very marked, though usually only transitory, improvement in disappearance of ascites, and are well worth trying in all these cases.

PERITONEAL BANDS AND ADHESIONS, CYSTS AND ASCITES

Isolated bands and adhesions may result from any of the foregoing peritoneal diseases, or follow after handling or exposing the bowel at operation; they frequently persist long after all signs of disease, etc., have ceased. They are of interest as frequently causing intestinal obstruction (Chapter XVI., p. 683)

Cysts of the peritoneum are usually parasitic and often occur in the abdominal viscera in countries where hydatid disease is common, the liver being especially affected; occasionally lymphatic and teratomatous cysts occur retroperitoneally or in the omentum or mesentery.

The cyst can be felt as a rounded and sometimes mobile mass, which may or may not give rise to symptoms according to its situation. Hydatid fremitus may be obtained if the cyst be adherent to the parietes, and eosinophilia will be present. If the cyst is ruptured great shock occurs, and frequently urticaria of the abdominal wall will appear and persist for a few days (Fig. 195). The Casoni reaction probably will be positive.

Treatment consists in laparotomy and excision where possible. Otherwise 2 per cent. formalin should be injected into the exposed cyst, which is then packed off (with black towels so that the cysts can be seen), opened (the daughter cysts will jump out, and must be excluded from the peritoneum), and marsupialised to the abdominal wall.

Ascites is a term used to indicate an exudation of serous fluid throughout the peritoneal cavity. It is met with :—

(1) In cardiac failure.

(2) In renal disease, in which case there is usually generalised dropsy (anasarca).

(3) In obstruction of the portal circulation from cirrhosis or other causes.

(4) In tuberculous peritonitis.

(5) In carcinoma of the peritoneum, in which there is wasting of the patient's limbs and face, in marked contrast to the distended abdomen.

(6) In acute obstruction.

Chylous ascites results from admixture of fatty globules from the thoracic duct, the fluid resembling milk in appearance; this may occur in rupture or obstruction of the receptaculum chyli (p. 397).

The peritoneum is usually generally thickened in cases of ascites, and adhesions are often present.

Clinically there are signs of free fluid in the peritoneal cavity. The abdomen is distended and resonant, owing to the bowel floating to the surface, but dulness can be detected in the flanks and in severe cases above the pubes. The level of this varies with the position of the patient, as the fluid naturally runs to the most dependent part of the abdominal cavity. A " fluid thrill " may be obtained if a hand is placed firmly on the centre of the abdomen, and then one flank is tapped briskly, while the other flank is palpated. Enlarged varicose veins often can be seen making a leash radiating from the umbilicus (caput medusæ), and piles are often present.

The *diagnosis* must be made between the various causes of the ascites, if it is certain this be present. Large ovarian tumours, hydronephroses, or encysted collections of fluid may cause errors, but not if care be employed in eliciting the signs; the convex upper limit to the dulness in these cases, and a band of resonance, which is also often present in the flank behind the swelling, will distinguish these causes.

The *treatment* may consist in laparotomy where a local cause is present, and in hepatic cirrhosis some benefit may result from the Talma-Morrison operation, which aims at obtaining an anastomosis between the portal and systemic circulations by promoting adhesions between the liver and the omentum, the parietal peritoneum, or the abdominal wall; in some cases surgeons have endeavoured to drain the peritoneal cavity via the crural canal into the subcutaneous tissues of the thigh by the use of transplanted veins, chicken-bone tubes, etc., but such methods are not usually satisfactory. The saphenous vein has been turned up and anastomosed to the peritoneum, its valves preventing the blood from flowing into the abdomen. Patterson's subcutaneous method of drainage by rigid tubes is occasionally of benefit.

In cardiac, renal and many malignant cases resort must be had to "tapping" the peritoneal cavity with a trocar and cannula. This operation is done with all aseptic precautions under local anæsthesia, and can be repeated frequently. The bladder having been emptied, and the anæsthetic injected at the area selected, usually the midline just above the pubes, the skin is incised and the trocar thrust boldly through the abdominal wall, a proceeding which may produce some shock. When no more fluid escapes, even on squeezing from the flanks, the trocar is withdrawn and the incision closed, and sealed with a collodion dressing. A tight wide binder must be applied.

THE MESENTERY

Surgical Anatomy. The mesentery, which is the double fold of peritoneum encircling the small intestine, is attached to the posterior abdominal wall on a line extending from the left side of the second lumbar vertebra, where it is very short and attached to the duodenojejunal flexure, to the right sacro-iliac synchondrosis, where it encircles the ileocæcal juncture. Between the two layers run the superior mesenteric blood vessels, which split into parallel branches, to be distributed to the whole length of the small bowel, lymphatics and nerve filaments. The lymphatics after a meal are white from contained chyle, and are often therefore called *lacteals*; along their course to the receptaculum chyli and the portal fissure of the liver they divide into capillaries and drain through a series of lymph nodes which are distributed irregularly through the mesentery.

Injuries of the mesentery may take the form either of perforating wounds, when the blood escapes into the peritoneal cavity, or hæmatomata following contusions of the abdomen, when the effused blood lies between the peritoneal layers.

In either case there may be sufficient damage to the vascular supply of the intestine to cause gangrene of the bowel and peritonitis. A hæmatoma after a traction-rupture is prone to occur near the duodenojejunal flexure, and may then persist as a *blood cyst of mesentery.*

The signs are either those of internal hæmorrhage (Vol. I.) or of thrombosis of the mesenteric vessels (see p. 559), and laparotomy is urgently called for; small wounds should be sutured after hæmostasis has been secured, and hæmatomata evacuated. The intestine must be examined for perforation which needs suture, or gangrene, the first and earliest signs of which are loss of muscle tone and absence of peristalsis on stimulation, when excision and suture of the cut ends of the bowel are required.

Diseases of the Mesenteric Lymphatics. *The lymph nodes* in the mesentery are frequently enlarged as the result of intestinal infection, and are usually most affected around the lower part of the ileum.

Acute inflammation occurs in typhoid fever, when suppuration may occur, and is common in infants after gastro-enteritis, when an enlarged gland may press on the ileum and apparently cause intussusception (Chapter XVI., p. 691).

Chronic enlargement is common and usually tuberculous, but also occurs in lymphadenoma, lymphæmia, etc.

Tuberculous mesenteric glands are most often present in young children, and produce a chronic intestinal toxæmia and wasting; hence the name "tabes mesenterica." Such glands frequently calcify, and may be seen in adult life on X-ray examination, when, unless a lateral view be taken, they may be mistaken for calculi, but their shadow is usually irregular both in density and outline.

Clinically the child wastes steadily, is fretful, and often has abdominal pain, with at one time diarrhœa, and at others constipation; vomiting is rare. Palpation may yield information, as sometimes the masses of glands can be felt; pelvic examination may disclose them.

In adults where calcified glands exist in the ileocæcal angle, symptoms suggesting appendicitis are often present, due presumably to involvement of nerve fibres in adhesions around the glands. Chronic abdominal pain is often due to old calcified glands, and if these press upon the ureter the pain will resemble renal pain. They may closely resemble renal or ureteric calculi in an X-ray film.

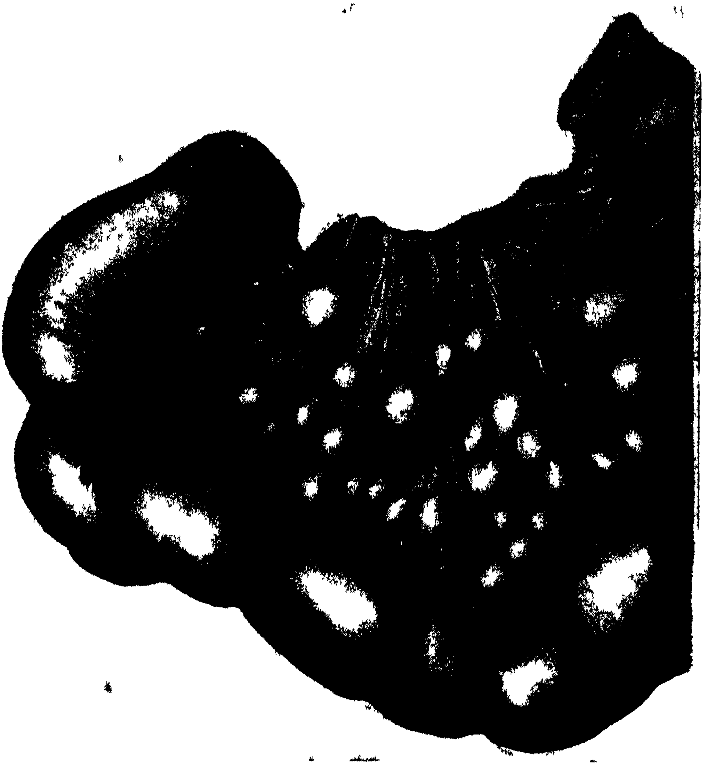


FIG. 194. "Tabes mesenterica," generalised tuberculous infection of the lymph nodes in the mesentery.

Treatment. In children with tabes mesenterica no operation is of any use, and satisfactory results accrue from giving cod-liver-oil, and heliotherapy or ultra-violet rays.

In localised tuberculous ileocæcal glands in adults relief follows excision of the calcified nodules; it is also well to remove the appendix, which is usually healthy.

Carcinomatous invasions occur in peritoneal and intestinal cancer, but are of secondary import to the primary focus. Unless they can be removed such glands contra-indicate radical operations on the neoplasm.

Secondary infection from the bowel with *abscess formation* is not uncommon in these mesenteric nodes; if this occurs laparotomy is necessary, with, if possible, excision of the abscess, or, failing this, drainage.

Affections of the Mesenteric Vessels. *Thrombosis* and *embolism* of the mesenteric blood vessels are not very uncommon, and are invariably fatal if extensive. The condition occurs in volvulus and strangulation of loops of intestine, but is sometimes not due to these causes (see also p. 695).

Clinically there is acute abdominal pain, and the patient vomits and may empty the bowel or strain to do so frequently at first. Blood-stained motions are passed. There is great collapse and intense thirst. The abdomen is distended and tender, and a vague mass may be felt in the centre, but often no definite diagnosis is possible without laparotomy.

Treatment. Immediate laparotomy is indicated, when the peritoneal cavity is found filled with blood-stained fluid, and coils of distended and œdematous plum-coloured bowel are protruded. The gangrene may extend throughout the whole small intestine, or affect only a few inches, according to the position of the thrombus. If small in amount excision and end-to-end anastomosis may give good results, but the clot often extends, and causes further gangrene with a fatal issue. In extensive thrombosis little can be done, as it is manifestly impossible to look for other than a fatal result if the whole small intestine be involved.

Tumours of the mesentery are very rare, and are usually lipomata or sarcomata invading it from the retroperitoneal tissues. Clinically such a tumour presents as a globular mass felt on palpation to lie in the line of mesenteric attachment, usually just about the umbilicus. The mass does not move on respiration, but can be pushed about from side to side.

The treatment consists in laparotomy, and removal if feasible.

Mesenteric cysts, though more frequent in occurrence than neoplasms, are by no means common. They are either lymphangiomata, when they may be single or multiple and may contain chyle, hæmangiomata (blood cysts may be modified hæmangiomata), or result from an unabsorbed hæmatoma, or occasionally be of teratomatous origin. Parasitic cysts also occur.

Clinically an ovoid elastic swelling, not moving on respiration, but often movable in the abdomen, is discovered on palpation. Fluctuation may be obtained.

The diagnosis from omental and pancreatic cysts and ovarian cysts is not often possible short of the laparotomy which should be carried out for their removal.

THE OMENTUM

Surgical Anatomy. The great omentum so prominently lying over the front of the intestine when laparotomy is performed is formed of four layers of peritoneum, the two anterior ones coming from the walls of the stomach, which they leave along its greater curvature, while the posterior ones are reflected to the transverse colon, which they surround, being continued back therefrom as the mesocolon. The two inner layers are part of the lesser sac, and the two outer part of the greater sac of the peritoneum, and between the two sacs the branches of the gastro-epiploic and middle colic vessels form a free anastomosis, while some lymphatics and lymph nodes also lie there.

In young children the two anterior layers of peritoneum are not attached to the transverse colon, but become so in adults, in whom the portion of the lesser sac included between the two inner layers becomes obliterated by adhesions.

Injuries of the omentum are frequent in wounds of the abdomen and the cut vessels bleed freely. The omentum also often projects through such abdominal wounds into the outer air, and if untreated forms a natural means of closure; on healing it fuses with and adheres to the parietes.

Omental wounds call for laparotomy to stop bleeding and also to deal with damage to other viscera. Omentum projecting externally may be cleansed with peroxide of hydrogen and returned to the abdomen, or ligatured and excised. If much fouled or crushed excision should be practised.

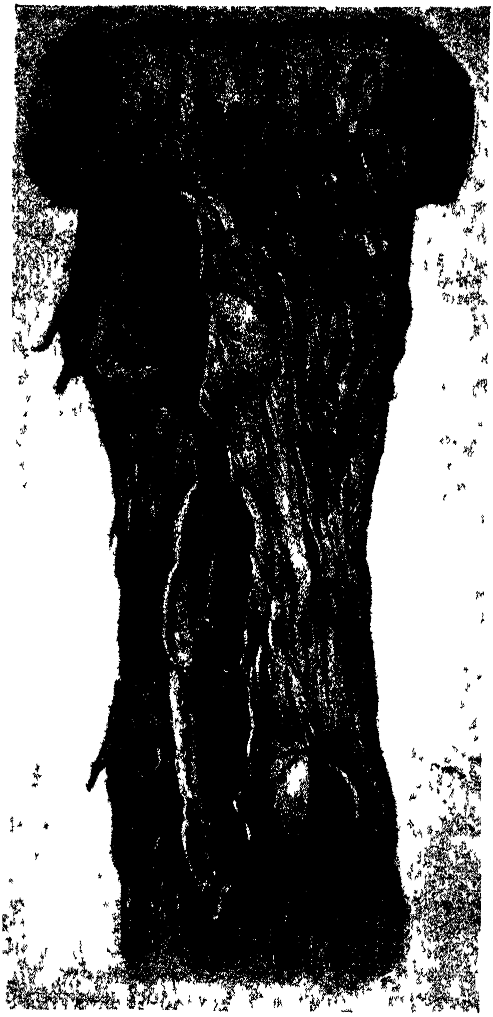


FIG. 195. Multiple hydatid cysts in the great omentum.

Inflammation of the Omentum (Epiploitis). As the omentum always moves to and encircles any inflamed viscus, projects into hernial sacs, and through abdominal wounds, being a natural protector of the peritoneum, it will be seen that it is very liable to infection. Moreover, infection may follow excision of parts of the omentum, where the operation is performed with instruments infected from the bowel.

The omentum appears thickened, matted, opaque, and there is usually some transudation of seropurulent fluid.

Clinically the patient may complain of a vague abdominal pain, usually after an operation for a hernia, where omentum has been removed. Examination shows some distension and the presence of a tender plaque-like mass in the abdomen.

When resulting from inflammation in other viscera the omentum forms part of the mass in the region of this viscus, the inflammation in which masks all signs of the epiploitis.

The *treatment* is expectant; if an abscess forms laparotomy must be performed and drainage carried out, or the affected area excised. When omentum is found inflamed around an infected viscus it should be peeled off, sponged with warm saline, and returned to the abdomen; attempts at excision usually spread the infection, besides removing a potent factor in dealing with this condition.

Chronic inflammation occurs in tuberculosis and other chronic diseases, the omentum forming a thickened mass in the epigastrium. Ascites is usually present.

Carcinoma of the omentum is usually secondary to disease in the abdominal viscera, and causes thickening and matting, as in chronic inflammation. Colloid degeneration is frequent and ascites usually present, often bloodstained.

Omental adhesions and bands attached to the parietes and other viscera commonly result from any of the above causes, and are a potent cause of intestinal obstruction from coils of bowel becoming strangulated through them (see p. 683) or over them.

Tumours are extremely rare, and *cysts* very uncommon in this situation. A cyst is usually lymphangiomatous and presents as an oval, freely mobile elastic tumour, which is usually taken for a pedunculated ovarian cyst if in a woman, but may be diagnosed in a man. Hydatid and teratomatous cysts occur.

The *treatment* consists in laparotomy and excision, which usually presents no difficulties.

Torsion of the omentum is occasionally seen. Though sometimes it involves large masses of omentum, especially if they are adherent to the anterior abdominal wall or to a hernial orifice, it occasionally affects only a small tag of omentum lying in the right iliac fossa. This small portion becomes congested, red, purple, and even gangrenous. These torsions may be described under the following headings :—

(*a*) Hernial—usually in association with a right inguinal hernia. The process may then be intrasacular or intra-abdominal.

(*b*) Abdominal—where it may be primary or accompanied by some other abdominal disease such as appendicitis.

The condition will resemble an acute gall-bladder or acute appendix closely. From one to ten twists may occur, the rotation being produced by movements of the bowel or of the body, possibly by venous congestion. It is usually seen in stout and middle-aged persons. Pain is marked, but the temperature and pulse are only slightly raised. A mass, over which there is tenderness and rigidity, is often felt and may exhibit marked lateral mobility. The only treatment consists in laparotomy and excision of the gangrenous portion.

CHAPTER XIV

HERNIA

The term "hernia" is usually taken, when used in its widest sense, to imply a protrusion of some viscus or part of a viscus through an opening or weak spot in the wall of the cavity in which it lies, the protrusion remaining, however, covered by a lining membrane or sac and by skin and other tissues. The term is thus applied to such conditions as hernia of the lung, hernia of the brain, hernia of the testis, etc., but in many cases these descriptions are grossly inaccurate, and in its most usual sense the term has come to be restricted to the abdomen alone and to denote a protrusion of some portion of the abdominal contents through an opening or weak spot at some part of the abdominal wall; it is in this sense only that we shall use it in this chapter.

There are certain situations where the abdominal wall is prone to give way and where therefore hernia is common, as in the inguinal region, femoral region, or the neighbourhood of the linea alba or umbilicus. Many herniæ are found to come out through or in the neighbourhood of abdominal incisions, while other and rarer types occur, such as the obturator hernia, sciatic hernia, lumbar hernia, diaphragmatic hernia, perineal hernia, or the pectineal hernia of Clocquet.

Structure of a Hernia. A hernia essentially consists of the contents, the sac which contains them and the overlying coverings, the sac always being formed by the peritoneum.

(1) *The contents* consist always of one or more of the abdominal viscera in whole or in part. In most cases the hernia is found to contain omentum or small intestine; the large intestine is more rarely present, the bladder is not uncommonly met with, while there is probably no viscus except possibly the pancreas which has not at some time or another appeared in whole or in part in a hernia. In many cases the special type of contents gives a special name to a hernia.

(*a*) Thus an *enterocele* is a hernia containing intestine. This is most commonly the small intestine, and the amount present may vary from about half an inch to several feet. When bowel has been in a hernia for some time, though it may remain unaltered, it is by no means uncommon for it to become adherent to itself, to the sac or to other contents, and this will be one cause of the onset of such complications as irreducibility, obstruction, strangulation, etc. These adhesions arise as the result of a chronic inflammatory process within the sac.

(*b*) If omentum only is present in the sac the condition is called an *epiplocele*. Omentum which has been in a hernial sac for some time, especially if it is irreducible and above all in fat people with large herniæ, becomes thickened and converted into a solid mass of fibrolipomatous tissue, while it also shows a considerable tendency to become adherent to the sac and to other contained structures. It actually may increase in size while in the sac as a result of this chronic inflammatory process and the deposit of fat, while the bands, adhesions and apertures which occur in and around it are not infrequently the causes of strangulation (see p. 569). In infants the omentum is only very slightly developed and therefore is rarely found in a hernia.

(*c*) Occasionally only part of the circumference of the bowel is found in a hernia; this is known as a **Richter's hernia.** It is obvious that this is only likely to occur in a small hernia and when it is strangulated, so that the bowel is nipped and held there. This will be further discussed on p. 573. The condition is most common in femoral herniæ, as the opening is lower and the mesentery may not be long enough to allow the whole lumen of the bowel to protrude.

(*d*) When Meckel's diverticulum is found in a hernia the condition is known as **Littré's hernia.** Both these last two conditions are most commonly seen in the case of a femoral hernia.

(*e*) When the large bowel or cæcum or the lateral wall of the bladder are found in a hernia it often happens that as these structures may have no proper mesentery they are found on the outer side of the sac, which is stretched over them, the peritoneum being reflected from their anterior or upper surface to the neck of the sac; in this case these organs appear to be sliding down outside and in conjunction with the hernial sac itself, so that the condition is sometimes known as a **hernia en glissade,** a sliding hernia or a sacless hernia. These herniæ usually contain either the bladder, cæcum or the pelvic colon and occur in middle-aged and elderly people. They cannot be diagnosed as a rule before operation, and at the operation they give rise to difficulties rendering a radical cure difficult and unsatisfactory; moreover, there is a considerable risk of opening the bowel or bladder.

The *appendix* is not infrequently found in herniæ on the right side, and when this is so, occasionally attacks of *appendicitis* occur *in the sac;* all the symptoms are referred to the sac, while after a few days the hernial swelling will become much increased, œdematous, red, and acutely tender owing to the formation of an appendix abscess within it. Apart from actual attacks of appendicitis, a hernia containing the appendix is usually abnormally tender, while the appendix can sometimes be felt within it. Appendicitis occurring in a hernial sac is undoubtedly much less dangerous than when the appendix lies in its normal situation, as the neck of the sac early becomes obliterated and prevents the infection from reaching the peritoneal cavity. In some cases strangulation of the appendix occurs, and when this is so the symptoms will closely resemble appendicitis within the sac.

Peritoneal fluid due to other causes is frequently present in the sac of a hernia, while it is not uncommon to find loose bodies formed of condensed fibrin lying in the sacs of herniæ which have been present many years.

(*f*) **Hernia of the Bladder.** This usually occurs in the inguinal region, where some portion of the bladder may be dragged downwards by the pull of the peritoneum as the sac enlarges, and it must be remembered in operating upon an inguinal hernia that if the sac is dragged upon it is nearly always possible to drag a small portion of the bladder wall into the wound.

The bladder appears in a hernial sac in two ways. Occasionally and rarely the intraperitoneal portion of the bladder lies within the sac, just as may any other abdominal viscus. More commonly, however, a portion of the wall of the bladder is attached to the outer side of the inner wall of the sac (hernia en glissade), so that the bladder itself forms as it were one of the coverings of the neck of the sac; this is most frequently seen in large herniæ. Inasmuch as any obstruction to the outflow of the urine increases the tendency to hernia of the bladder owing to the viscus becoming dilated and even pouched, it is sometimes found that the part of the bladder involved in the hernia is only a thin-walled diverticulum or sacculus. The condition is not often diagnosed before operation, though occasionally there will be a history of frequency of micturition or the patient may state that the hernia is larger when his bladder is full, that it diminishes in size on micturition, that pressure on the hernia causes a desire to pass water, or that micturition is assisted if he manually compresses the hernia. The diagnosis will be confirmed sometimes by means of the cystoscope. When the bladder is present at the neck of the hernia it is in danger of being wounded during an operation for radical cure. Stones have sometimes formed in the part of the bladder dragged out into a hernia and even have been removed through a hernial incision.

Treatment. The existence of the bladder in a hernia, if diagnosed, is a strong indication that the hernia should be operated upon and a radical cure performed upon the lines indicated below. The bladder sometimes (but not always) may be recognised near the neck of the sac during an operation for hernia by feeling a firm pulpy mass there, by identifying the muscular fibres, or from the large amount of extraperitoneal fat which may surround it. Should the bladder be opened accidentally during the operation and the condition be recognised, it should be sutured promptly with a continuous catgut suture and a small drain left in the wound, but not in the bladder, this organ being kept empty for four or five days by a rubber catheter tied in through the urethra. In other cases the bladder has been included in a stitch accidentally; in this case the patient will pass blood-stained urine and complain of pain and frequency of micturition. When this is recognised within a day or two of the operation it is better to reopen the wound and remove the offending stitch, as otherwise the frequency and pain may become permanent.

A similar protrusion of the bladder into the vagina in women who have had many children, and known as a *cystocele,* is common. Works on Gynæcology must be consulted for a description of this condition. (See also Chapter XXII.)

(*g*) The ovary or Fallopian tube is sometimes discovered in a hernial sac, usually that of an inguinal hernia. The condition is most common in children, in whom the state of affairs may be diagnosed by feeling the ovary moving about within the hernia as a smooth, round, firm body, while the Fallopian tube may be felt attached to it. Pressure upon the ovary causes a dull, aching, sickening pain. As the child grows the ovary frequently will withdraw into the abdomen again. When the condition occurs in adults it is usually obvious owing to the ovary becoming swollen and tender at each monthly period. The treatment of this condition is the same as that of any other hernia.

(2) *The sac* of a hernia is the peritoneal pouch in which the protruded viscera lie. In the early stages it consists of normal peritoneum, which is thin and shiny and is funnel-shaped, being narrow at its proximal part where it joins the rest of the peritoneum, this being known as *the neck* of the sac, and broadening out towards its distal end, which is called *the fundus.* In many instances, however, sacs are multilocular or hour-glass-shaped, while it must be remembered that a sac is often present without any contents within it. It is, of course, derived from that part of the peritoneum which lies over the weak spot in the abdominal parietes through which hernia protrudes. As the rupture increases in size the sac becomes larger, thicker and irregular in shape, while its neck may remain small and narrow, may become even narrower by a process of fibrosis setting in and around it, or not

infrequently becomes stretched and enlarged, so that the sac loses its funnel shape and becomes a rounded bulge owing to the continual pressure of the abdominal viscera being forced into it. It must not be forgotten that the sac of a hernia is permanently in place, is fixed to the surrounding tissues and remains in statu quo and unreduced, when the contents themselves are reduced.

As a result of irritation either by the abdominal viscera or from wearing a truss, the sac becomes more adherent to the surrounding structures as well as losing its thin, transparent appearance and becoming greatly thickened; while a certain amount of chronic inflammatory reaction will occur which at times will give rise to a densely hard, thick, white sac with large vessels running in its walls; the same process leads to adhesions within the sac, either binding its two walls together or causing the contained viscera to become matted. In this way either the neck or some lower portion of the sac may become blocked by adhesions or by an adherent plug of omentum, thus shutting off the peritoneal cavity. In some cases this will lead to a natural cure of the hernia, but more commonly the unobliterated terminal portion of the sac will become filled up with a serous effusion, and the condition is then known as a **hydrocele of a hernial sac.** This latter condition is especially common in femoral hernial sacs.

A hernial sac often will participate in and become involved in any disease which affects the rest of the peritoneum, becoming tuberculous or infected by other organisms.

If an empty hernial sac remains for a long period undisturbed and no contents enter it, it shrinks and may become obliterated and converted into a fibrous strand, thus curing the hernia.

(3) *The coverings* of the sac vary according to the situation of the hernia and are derived from the various layers of the abdominal wall through which the hernia bulges, while they become altered by the continual stretching and pressure to which they are subjected. This process causes them to become thick, matted and indurated, these changes being most marked at the neck of the sac. In addition to these changes the various layers through which the hernia passes become slightly displaced, and the neck of the hernia and the track down which it passes tend to become larger and rounder, while the hernia which originally passed through the abdominal wall in an oblique direction continually tends to straighten its course, and so finally it tends to pass directly outwards.

Etiology. Herniæ are divided into the two broad classes of those which appear more or less spontaneously at certain rather weak spot sin the abdominal wall and those which are due to the abdominal wall being weakened as the result of injuries, operations, and the formation of scar tissue.

Those cases which form at the site of injuries or incisions are undoubtedly due to the effect of the pressure exerted by the abdominal contents, especially when increased by continual coughing or muscular efforts, the process gradually stretching the scar and separating the muscles. In post-operative cases this process undoubtedly will be assisted if the wound has been weakened by suppuration in it, by an incision which has been designed or made or sutured in a faulty fashion, or by any damage done to the muscles and nerves of the abdominal wall.

In the case, however, of the more truly spontaneous herniæ, such as appear in the femoral, inguinal, umbilical, and other regions, considerable difference of opinion exists with regard to the actual cause.' There is no doubt that such sites as the inguinal canal, the crural canal, and the parumbilical tissues may be regarded as weak spots in the abdominal wall, and some authorities hold that this combined with the effects of continuous abdominal pressure due to chronic cough, heavy work, continuous muscular strain, and even isolated injuries are sufficient to account for the gradual appearance of herniæ at these spots. The opposite school hold, however, that the development of a hernia in these regions is due to the presence of a preformed sac, namely a congenital or developmental pouch or diverticulum of the peritoneum, which is there ready for the hernia to pass into it, and that it is only when these preformed sacs are present that muscular exertion can cause the hernia to protrude ; there is a considerable amount of evidence to support this view, such preformed sacs being found sometimes on dissection in people who have no hernia. In the case of the inguinal hernia the non-obliteration or partial obliteration of the funicular process supplies an obvious possibility for the origin of the hernia and of the preformed sac, and it is probable that all indirect or oblique inguinal herniæ (see p. 580) are due to this cause ; for it must be remembered that a sac may be present and yet the hernia not come down into it or appear until adult life. Similarly, in the female it is probable that the peritoneal tube, known as the canal of Nuck, is present in and responsible for all cases of inguinal hernia, while a like possibility arises in the herniæ near the umbilicus. The presence of a preformed sac is, however, not so easy to explain in the case of the femoral hernia, though some authorities hold that the outgrowth of the femoral vessels may drag a pouch of peritoneum with them ; in our opinion the theory cannot be regarded as providing an explanation of *all* acquired herniæ.

Predisposing Conditions. There are, moreover, certain other congenital conditions which play a part in the production of herniæ ; there is a tendency for the condition to run in families, and it may be that this is an inherited weakness of the abdominal musculature and a marked patency of the rings, while an abnormal length of the mesentery or the presence of visceroptosis will assist in the production of the condition. Imperfect closure of the umbilicus at birth, congenital apertures in the linea alba or other parts of the abdominal wall, especially opposite one of the tendinous intersections of the rectus and the presence of such congenital conditions as phimosis, narrowing of the anus, etc., may all be regarded as predisposing causes.

With regard to acquired causes and predisposing conditions, it will be found in the elderly that visceroptosis and elongation of the mesentery, combined with failure and weakening of the abdominal musculature, will favour the formation of a hernia, especially if this is associated with severe muscular straining. This in old age may be assisted by the presence of chronic cough, carcinoma of the colon, a stricture or a large prostate. It is thought possible that the slipping down of the mesentery which is seen in old people is due to weakening of the muscle of Treitz, which helps to maintain the mesentery in its proper position, and that this renders the formation of a hernia easier, for it must be remembered that with a mesentery of normal length and situation a loop of bowel cannot be brought down into the inguinal or femoral canals. In the female there is no doubt that pregnancy and parturition stretch and weaken the abdominal wall and assist in the formation of a hernia in any of the usual situations, while in either sex the presence of obesity by increasing the intra-abdominal pressure and diminishing the strength and tone of the muscles is also an important factor. There are other conditions which are undoubtedly predisposing causes, all of which may be included under the group of chronic strain, laborious occupations, heavy lifting, straining to pass water when an obstruction to the urinary outflow is present, constipation, and straining at stool being the most important. The evil effects of these conditions are all increased if the actions and movements concerned take place with the body erect, as flexion of the thighs and hips tends to protect and reinforce the groins.

With regard to the *influence of accidents and injuries* upon the formation of a hernia many important medico-legal points exist, and many claims for compensation arise in this connection. It can be taken as certain that a single violent muscular strain or accident will never cause a hernia of considerable size to appear for the first time unless a preformed sac is present. Small herniæ, however, may arise de novo as the result of single strains, and existing herniæ may be made larger. Should a pre-existing sac be present and a hernia suddenly be forced down into it for the first time, strangulation is quite likely to occur there and then. Careful enquiry should be made as to the possible existence of a hernia before an accident which is said to have caused it. With regard to compensation, it should be remembered that even should a preformed sac exist, the Court probably will find that an employer is still liable if a hernia is forced into it as the result of an accident.

CLINICAL CONDITIONS AND COMPLICATIONS OF HERNIÆ

A normal uncomplicated hernia is said to be **reducible**, which term implies that the contents of the hernial sac can be completely reduced so that they leave the sac and pass back into the abdominal cavity. This process may take place spontaneously or may need the surgeon's aid to effect it.

Reduction of a Hernia. This process is known as *taxis*, and if it is necessary is accomplished as follows : The patient lies down with his head low, his feet raised, and his limbs and body placed in such a position as will as far as possible relax the hernial opening and the parts surrounding it; in the commoner femoral and inguinal herniæ this entails slightly abducting, internally rotating and flexing the thigh. The fingers of one hand then steady and fix the neck of the sac, while the other hand applies steady pressure upon the contents, endeavouring to press first those near the neck and finally those in the fundus back into the abdomen. No force should be applied, and the manipulations should not be persisted in for long. The direction in which the pressure is applied naturally depends upon the type of hernia. In an inguinal hernia the contents are pressed upwards, outwards and backwards, in an umbilical hernia they are pressed backwards, while in the femoral variety the pressure is first downwards, then backwards, and then upwards and inwards. When taxis is complete all swelling should disappear. Omentum, if present in the sac, slips back noiselessly, but sometimes may be felt to be rough and knotty; bowel on the other hand often slips back with an appreciable gurgle, but feels quite smooth.

Clinically a reducible hernia gives rise to a soft, rounded, often pyriform swelling, situated at one of the standard hernial sites, which may come and go and probably will vary in size from time to time ; in many cases the patient is quite unaware of this swelling and may complain only of colicky pains. When he coughs or strains, the swelling exhibits an expansile impulse so that it suddenly and sharply increases in size, this being a very characteristic phenomenon and known as an *expansile impulse on coughing*. If only bowel is present the swelling is smooth, rounded, uniform, resonant on percussion, and when reduced gives rise to a characteristic gurgling ; it also may be associated with a certain amount of indigestion and abdominal discomfort. If only omentum is present the hernia is doughy, uneven or knobbly to the feel, dull on percussion, and reduces without a gurgle. The impulse on coughing is always more marked when bowel is present in the sac. The swelling due to a reducible hernia nearly always becomes smaller when the patient lies down. The symptoms due to a hernia are very slight and in many cases are completely absent. Pain in the region of the hernia is most common in strong and muscular subjects and is usually most severe in the early stages when the hernia is quite small or even has not yet appeared. The tendency of a hernia is continually to increase in size, while at any time any of the complications described below may supervene. A rupture which is large and has been present for some years is not likely to remain reducible.

Certain special tests and methods of examination will be discussed in connection with individual herniæ.

There are only two possible lines of treatment for a reducible hernia, either an operation for a radical cure or the fitting of a proper truss. These will be described under the various varieties of hernia.

Irreducible Hernia. This is a common variety in which the contents of the hernia cannot be returned completely within the abdominal cavity. There are many causes of this condition, the commonest being the formation of adhesions within the sac, either between the contents themselves or between the contents and the sac wall, such adhesions most commonly involving the omentum and in all cases resulting from inflammation of the contents. In other cases excessive deposit of fat in the omentum, the formation of cysts, and the contraction of the neck of the sac from the pressure of trusses or of the hernial contents, will be the cause. In some cases the hernia is so large and contains so much material that there is not enough room within the abdominal cavity for all the contents to be reduced.

The *symptoms and signs* are similar to those of a reducible hernia, save that reduction is impossible while indigestion, colicky pains, and a sense of weight and dragging are far more common. The impulse on coughing is usually less, but is still present. It must be remembered that irreducibility is a serious condition, for it prevents the fitting of a proper truss and greatly increases the liability to obstruction and strangulation (see p. 566).

Treatment. The only satisfactory treatment for irreducible hernia is a radical cure by operation, the contents being set free by separating the adhesions and then being returned within the abdomen; the hernia is then cured by one of the methods to be described later. It is usually best to remove any adherent omentum. The operation may be very difficult on a large hernia, as there is barely room in the abdomen for the contents. In these cases, therefore, some preliminary treatment well may be undertaken, such as dieting to reduce fat, rest in bed with the feet elevated, and an ice-bag applied to the rupture, or fairly severe attempts at taxis at intervals with rest in bed in between. If operation is impossible or is refused no ordinary truss can be fitted, but the hernia may be supported by an elastic bag, an excavated pad, or what is known as a hinged-cup truss.

Inflamed Hernia. This is a condition in which there is localised inflammation both of the peritoneum forming the sac wall and of the contents. The condition frequently comes on as the result of mild infection from inflamed bowel, but is not infrequently the result of injury or attempts at taxis. The hernia in severe cases becomes hot, painful, swollen, and the skin over it congested and red, while there is a small amount of fever, malaise, nausea or vomiting, constipation and rise of pulse-rate. Irreducibility if not previously present nearly always sets in either at once or later as the result of adhesions. Rarely suppuration may supervene, when all the signs of an abscess in the sac will develop. It will be seen that this condition may resemble strangulation, but it can be distinguished therefrom by the fever, the small amount of vomiting, and the absence of abdominal signs and symptoms and of shock and tension in the sac. This condition is hardly ever seen except in umbilical and femoral herniæ.

Treatment. If satisfied that strangulation is not present the treatment consists in rest in bed, light diet, fomentations applied to the hernia and an enema if required. Operation should be avoided if possible until the inflammation has settled down, but if there is any doubt as to whether strangulation is present or not, it must be proceeded with.

Obstructed Hernia. In this condition, owing to pressure, twisting or kinking, the passage of fæces along the bowel within the sac becomes prevented, without there being any interference with the blood supply of the bowel wall. The condition only involves the large bowel and is most commonly seen in constipated women with irreducible umbilical herniæ; the obstruction is probably assisted by an accumulation of flatus. The patient complains of severe colicky pains and vomits; constipation is marked, but there is no rise of temperature and little rise of pulse rate; the impulse on coughing is usually still present. The hernia becomes swollen, tender, irreducible and doughy to the feel, but never hard and tense as when strangulated. If not properly treated, severe obstruction or even strangulation may supervene. This condition is sometimes known as "incarcerated hernia."

Treatment. This consists in rest in bed with the feet raised, the administration of enemata and an ice-bag upon the sac for a few hours, to be followed by kneading and gentle taxis. If the symptoms are not soon relieved operation will be required.

STRANGULATED HERNIA

Strangulation is by far the most serious complication of a hernia, which is said to be strangulated when from one cause or another the contents are so constricted or pressed upon that their blood supply is interfered with, the venous return being obstructed and the arterial blood being cut off. There need not necessarily be obstruction to the passage of fæces, and if omentum alone is involved there will be no obstruction. If, however, bowel is strangulated, obstruction is almost certain to be present, except in the case of Richter's hernia (see p. 563) and Littré's hernia (see p. 563). It must be remembered that strangulation of the bowel may be caused by conditions other than hernia, such as bands or adhesions, apertures in the mesentery and internal herniæ of various kinds. We are here only considering that form due to external herniæ, the others being described in Chapter XVI.

Strangulation is a grave complication, involving considerable risk to life, partly from the obstruction, but still more from interference with the blood supply to the bowel, with its risks of gangrene and infection. In some cases the strangulation occurs on the very first occasion on which the hernia appears. This entails a preformed sac, and most commonly occurs in children and young adults after sudden exertion, while the hernia is usually long and narrow. More commonly, however, the hernia is known to have been present and the strangulation is caused by the forcing into the sac of a small amount of additional contents as the result of some sudden effort, such as a fall, coughing or that dangerous pastime, straining at stool. If the hernia is old-standing and the neck or other parts of the sac thick and contracted, and especially if the hernia is irreducible, the condition is all the more likely to occur.

The site at which the constriction occurs depends upon the type of hernia and varies considerably. It is most commonly found to be either at the neck of the sac or just below this, while in other cases it is due to thickened rings of tissue in the wall of the sac lower down or to adhesions within the sac. The actual sac wall itself sometimes causes the constriction, while at other times tense and hard structures outside the sac, such as Gimbernat's ligament, the linea alba, or masses of scar tissue, are the cause.

Pathological Changes. (*a*) If the omentum alone is strangulated it undergoes a process of venous congestion, becoming dark red or purple, adherent to the sac wall, infiltrated and thickened, and provided no bowel is present in the sac, this may be the only change which occurs; in severe cases, however, it will go on to gangrene, the omentum involved becoming friable, ashy grey or brown in colour. If bowel is present in the sac the omentum will share in the inflammatory changes which occur from the result of the organisms in the bowel passing through its congested and damaged wall.

The effect of the strangulation will depend naturally on its tightness and the completeness with which the blood supply is cut off, and it must be remembered that it is not likely that absolute and complete arrest of the circulation will occur at the commencement. Moreover, at first the veins will be more affected than the arteries, so that in all cases the strangulated tissues will become engorged with blood almost immediately, while later, from the arterial supply being cut off, and still more as the result of infection from intestinal bacteria, actual gangrene may supervene.

(*b*) When the bowel is strangulated, venous congestion is well marked and the bowel becomes swollen and firm, pulpy, and of a colour which may vary from dusky red or chocolate brown to purple, blue or even black, according to the tightness and duration of the constriction. The loop becomes rapidly distended with gas, partly because both its ends are blocked and still more because its walls are paralysed, and bacterial activity both within the bowel and in its wall is great; moreover, the contents of the bowel become blood-stained as a result of the venous congestion. For a time the peritoneal coat of the bowel remains shiny and smooth, and the bowel retains its tone and peristaltic action. Ecchymoses will be seen in its wall and a blood-stained exudation will fill the sac, causing it to become hard and tense. If the strangulation is relieved at this stage the bowel will recover, but the two ends of the loop should be examined at the site where the actual constriction has occurred, for there a deep groove in the bowel wall will be found where all the changes are more advanced than elsewhere. This so-called *constriction groove* is pale and narrow, with punctiform hæmorrhages on it, while the mucous membrane at that site is often found to be ulcerated, and gangrene may be commencing here although it has not involved the rest of the loop. Should the bowel recover after the strangulation is relieved the damage done to its walls at these two points where it was constricted may give rise to sufficient scar tissue later on to form an annular fibrous stricture.

If unrelieved, further and more advanced changes occur in the bowel, and they are the result of the combination of bacterial infection of its wall and gangrene due to lack of blood supply. The colour deepens, and finally, when gangrene sets in, the bowel may become yellow, ashy grey or green; it loses its tone and becomes soft and flabby, like wet blotting paper, exhibiting no peristaltic wave; its peritoneal surface loses its lustre and becomes rough and shaggy. The fluid in the sac becomes darker and has a foul fæcal odour, while the peritoneum of the sac wall also becomes inflamed, rough and shaggy. The organisms which are responsible for these changes are chiefly Bacillus coli, streptococci, staphylococci, and the other inhabitants of the intestinal track. Gangrene usually commences at several spots, which fuse and run together, while the commonest spot for it to commence is at the bottom of the constriction grooves. The gangrene may involve the entire loop in the sac or only parts of it; it is more common in femoral and umbilical herniæ than the other varieties, more often seen in small herniæ than large ones, in recent ones than old-standing ones and in old than young patients, while it does not usually develop under forty-eight hours, although cases are occasionally seen where it is present within twelve hours of the onset of strangulation. In severe cases the sac itself actually may become gangrenous.

If the condition progresses still further the bowel wall actually sloughs and gives way, so that its contents are extruded into the sac and a large, infected fæcal abscess is formed. This process will be accompanied or usually preceded by œdema, redness and congestion of the skin and surrounding tissues, while finally the skin will give way, the abscess be evacuated and a fæcal fistula form, and in some cases this has led to a spontaneous cure. It must be remembered that though in the majority of cases the sac is full of foul, dark fluid, a few cases will be seen where the sac is dry, and in these cases care must be taken when performing the operation not to open the bowel. Naturally peritonitis will set in soon if the bowel is in any of the above conditions.

Above the point of strangulation the intestine, which is completely obstructed, becomes rapidly distended with gas and fluid; bacterial activity becomes marked, so that an infective enteritis is set up, the walls becoming red, congested and infiltrated, whilst ulceration of the mucous membrane occurs and there is a rapid absorption of toxins from this portion of the bowel (see p. 678). This process is soon followed by complete paralysis of the bowel, and in a few instances general peritonitis, with or without actual perforation of the bowel wall, will set in. The pressure and distension is sometimes sufficient to cause gangrene above the constriction. The portion of the bowel nearest the constriction exhibits these changes most markedly. The bowel below the constriction retains its usual colour, and is generally found to be collapsed and empty.

It must be remembered that even if the strangulation is relieved before gangrene sets in the bowel may yet not recover as a result of the thrombosis and inflammation it has undergone, and paralysis, infection and peritonitis or actual gangrene may still follow, for the vitality of the bowel wall may have been so damaged that the onslaughts of the intestinal bacteria prove irresistible.

A rare condition known as *retrograde strangulation*, or *Maydl's strangulated hernia*, is sometimes seen, and in this condition a loop of bowel passes into the sac, back into the abdomen, then out into the sac again, and then back into the abdomen, forming as it were a " W." It sometimes happens that only the returning loop within the abdomen is strangulated, while in other instances all the bowel concerned, both that within the sac and that within the abdomen, will be involved.

Natural cure of a strangulated hernia containing bowel is highly unlikely, as the congestion and swelling are such that reduction is almost impossible. A few cases have recovered as the result of the formation of a fæcal fistula as described above, but in all other cases, unless the condition is soon relieved, death ensues from obstruction, peritonitis and toxæmia.

Clinical Features. The signs and symptoms of a strangulated hernia are very largely those of intestinal obstruction, with the addition of local signs and symptoms pointing to the presence of a hernia which has undergone certain characteristic changes. There will be considerable variation in the severity of these symptoms according to whether the strangulation is tight or not, to how long it has been present, and to whether the bowel or only omentum is involved. As a rule the patient is aware he has a hernia, although a few cases are seen in which the hernia strangulates at its first appearance, while in many cases the patient is also aware that a change has occurred in that hernia. The strangulation is often preceded by one or two minor attacks or threatenings. The signs and symptoms may be divided into general and local ones.

(*a*) *The general signs and symptoms* are those of intestinal obstruction combined with a varying degree of collapse. These are described in full on pp. 678, 679, and, therefore, we shall only refer to them here. Usually, after a sudden effort such as falling, coughing or straining, severe pain occurs in the hernia, followed almost at once by abdominal pain around the umbilicus, acute, and with colicky exacerbations and often accompanied by shock. Thus there may be sweating, coldness, prostration, faintness, subnormal temperature, and a pulse which for at most a few hours is slow and weak. This shock is sometimes only very slightly marked and is most common in young patients and small herniæ. Nausea and vomiting soon follow, the latter being almost constant and consisting first of undigested food, then becoming bile-stained and finally foul, dark brown, and even black. This latter foul, dark vomit is sometimes referred to as "fæcal vomiting," although it in no way resembles fæcal matter. *It cannot be too strongly insisted upon that the so-called "fæcal vomiting" is a symptom not of obstruction but of impending death.* Vomiting is more marked the higher up the portion of bowel affected; it is rare when the colon is strangulated. The pain persists, becomes more severe and more generalised, while should it cease it is a bad sign and may indicate that the bowel has become gangrenous. Constipation is usually absolute, though a little flatus or fæces may be passed in the early stages from the lower bowel. In Richter's hernia, however, the bowels rarely may continue to act. The temperature remains subnormal; the pulse is small, but becomes more and more rapid. The face becomes pale and anxious, while thirst and dryness of the tongue are marked, the urine is scanty, and later contains albumen.

On examination of the abdomen visible coils and peristalsis may be detected, and on auscultation peristalsis is hyperactive. There is no rigidity and the abdomen is not tender at first, but soon becomes tense, distended and tympanitic; tenderness sets in later. In the early stages, at any rate, the condition of the patient may give no indication of how serious the lesion is or is likely to become and many patients walk into the hospital. If unrelieved the patient becomes exhausted, profoundly toxic, the facies Hippocratica develops and he finally dies from toxæmia or general peritonitis (see also Chapter XIII.).

(*b*) *Locally* definite changes occur in the hernia; a tumour at the site of the hernia is always palpable, and it cannot be too strongly insisted upon that *in every case o abdominal pain the hernial apertures should be palpated.* The hernia, which previously may have been reducible or irreducible, now becomes absolutely irreducible. It is tender, larger than usual and, the most important feature of all, *hard and tense ;* no hernia which is not hard and tense is strangulated. The expansile impulse on coughing disappears below the constriction and great pain in the hernia is also complained of. If bowel is present in the sac the swelling will be resonant on percussion, but not otherwise. It should be remembered that the patient may be unaware that he has a hernia and that in stout people a small hernia may not be noticed easily ; it should also be remembered that if a patient who happens to have a hernia gets intestinal obstruction from some other cause, as the abdomen distends the hernia will fill up with distended bowel and become larger than usual ; it does not, however, become tense, or irreducible or lose its impulse.

When gangrene supervenes the temperature falls lower, pain may cease, the pulse becomes weak and rapid, vomiting more persistent and the patient becomes cold and clammy. The hernia may become less tense, less painful, and the skin over it becomes œdematous and dusky or red. If the patient lives long enough the skin may slough and the tissues become crepitant. Gangrene usually sets in much sooner in the elderly than in the young and in femoral herniæ than in any others.

Many cases are seen in which the symptoms are modified or less severe ; thus *if only omentum is present* in the sac the symptoms of obstruction will be absent, and the strangulation is usually much less tight. The same local changes occur in the hernia, but there is less vomiting, less pain, shock, and constipation. Abdominal distension and visible peristalsis do not occur. If, however, the condition is allowed to persist unrelieved after some days a paralytic condition of the bowel or general peritonitis may set in, and the condition will then become as serious as though the bowel were strangulated. Any abdominal symptoms suggestive of obstruction, which are due to strangulation of omentum, must be at first of a reflex nature.

Strangulation of a Richter's hernia or a Littré's hernia gives rise to a somewhat different group of symptoms in the early stages, obstruction being incomplete at first ; the patient may pass flatus and fæces, so that the pain, vomiting and distension will be less marked. The shock and general symptoms are as a rule the same as usual, but it should be remembered that inasmuch as it nearly always occurs in a femoral hernia and frequently in stout people, the tumour due to the hernia is very small, and the swelling is often not detected, though if detected it has the characteristics of any other type of strangulated hernia. For this reason the prognosis is more grave than in other cases of strangulation, while it should be remembered that the constriction is tight and the risks of local gangrene or perforation of the bowel greater.

One important point to be noted in connection with any form of strangulated hernia is that in elderly patients, in whom the condition is the most urgent as gangrene sets in more quickly, the shock, vomiting, pain and rise of pulse-rate are usually less marked than in the young. The differential diagnosis of strangulated hernia will be dealt with later in connection with the individual herniæ.

Treatment. The only wise treatment for a strangulated hernia is immediate operation, although it may be permissible in cases of very recent strangulation to make a gentle effort at taxis as described on p. 567. This, however, must be extremely gentle and not be prolonged for more than a few minutes, contents being protected and kept out of the way with either a winged hernia director or the finger; it is better to make two or three small nicks in the constriction than one large cut. The actual structures to be divided and the direction in which the knife must be passed, of course, will depend upon the variety of the hernia, and this will be discussed on pp. 594, 601, 605.

Once the constriction is divided the structures in the sac must be drawn down carefully in order that the actual spots upon which the constriction pressed may be examined carefully.

(1) Omentum is easily dealt with; if apparently normal or very little damaged, it may be returned within the abdomen, but in most cases it will be wiser to ligature and cut away that portion which has been in the sac, returning the stump within the abdomen.

(2) The question of what should be done with the bowel, however, may be much more difficult. The constriction groove must be pulled down and carefully examined, as it is at this spot that the changes in and damage to its wall will be most advanced. The cases met with clinically may be divided into the three main groups of those in which the bowel is obviously viable, those in which it is obviously gangrenous and, the commonest group, those in which its condition is doubtful. It will be seen, therefore, that a most important decision has to be made as to whether the bowel is fit to return within the abdomen, or whether it must be removed.

(*a*) The bowel may be regarded as certainly viable and as fit to be returned within the abdomen if it retains its tone and feels firm and elastic and not soft and pulpy like wet blotting paper, if its peritoneal coat retains its shininess, if its colour is red or not too dark a purple, if on pinching it or flicking it a wave of peristalsis can be started, and if, after the constriction has been relieved, and the bowel has been wrapped for a minute or two in cloths which have been wrung out of warm saline, it changes its colour and becomes a lighter red. Attention should also be paid to the condition of the mesentery: if this is unaffected and not swollen and engorged with blood, while its vessels are not thrombosed, this is a very favourable sign.

(*b*) In cases which are obviously gangrenous some parts of the bowel, either a whole loop, the constriction groove, or one or more patches on the bowel wall, are grey, yellowish or green and stinking. On opening the sac there is a fishy smell, while the bowel is toneless and feels flabby, like wet blotting paper, being devoid of peristalsis or elasticity; the peritoneal coat has lost its shininess, there is no change in colour after immersion in hot saline for a minute or two, and the mesentery usually will be found to be thickened, infiltrated, engorged with blood, red or purple in colour, and with its vessel thrombosed.

(*c*) The doubtful cases, which are by no means uncommon, must be decided by a consideration of the points already mentioned. Black may be considered the most doubtful colour, while loss of peritoneal shininess, though suggestive of gangrene, is by no means conclusive. Loss of tone, elasticity and peristaltic wave and absence of change of colour when the bowel is wrapped in pads soaked in warm saline for a few minutes and the anæsthetist is asked to give a high concentration of oxygen (a procedure which should always be undertaken) are the points most suggestive of nonviability.

The procedure next to be adopted depends upon the condition of the bowel If it is clearly viable it should be returned within the abdomen after careful irrigation and cleansing. This sometimes will be difficult to do owing to it being stiff and swollen from effusion into its walls. It may be squeezed gently with damp pads to reduce its œdematous condition, and usually then can be coaxed back into the abdominal cavity. It must be remembered that its infiltration and congestion render it unduly friable, and all manipulations therefore must be as gentle as possible. A decision usually can be made about the doubtful cases if the bowel is carefully examined and watched for a few minutes. If it is of doubtful viability it should be returned just within the abdomen and allowed to remain there with a large drainage tube reaching down to it, so that should gangrene, perforation or ulceration occur, the general peritoneal cavity will become shut off by adhesions, and a track is left for the escape of intestinal contents or pus. There is no need to fix the bowel in position at this spot, as owing to its infiltration and paralysis it is not likely to move away from it.

In cases where the bowel is gangrenous this process usually affects the whole loop or one or two inches of the bowel wall. More rarely, however, there may be only one or two small patches of gangrene, or just a narrow ring of gangrenous tissue at the bottom of the constriction groove. In a few cases it may be possible to invaginate these small gangrenous areas with a row of Lembert sutures, but it is not often that this can be considered a wise procedure, for it must be remembered that the bowel around is soft, infiltrated, and certainly of doubtful viability. It, however, sometimes does happen that cases will be seen where, although most of the bowel in the sac is in good condition, a small strip at the bottom of the constriction ring is going gangrenous, and this well may be invaginated and the bowel returned to the abdomen.

In most cases, however, where the bowel is gangrenous, it will be necessary to remove it. Some surgeons advise that the bowel should be opened and drained with a Paul's tube for a few days and that the resection of the gangrenous portion with the union of its ends should be performed at a later date (see below). We do not agree with this, however, and in the case of a strangulated hernia where the small bowel is gangrenous prefer to do an immediate resection and reunion unless the patient is desperately ill. If a resection is necessary some modification in the incision will be required, as otherwise it will not be possible to drag down as much bowel as is required, nor would it be easy to reduce the anastomosis through the hernial opening after it has been performed. In the case of an umbilical or inguinal hernia, all this can be done quite easily by enlarging the original incision, but in the case of a femoral hernia it is better to open the abdomen by a separate incision in order to perform the resection rather than to enlarge the original incision upwards, as this would entail dividing Poupart's ligament.

A formal resection of the intestine is then performed, the resection being carried some little distance up above the apparent limit of the gangrenous bowel, in order to ensure that the sutures are passed through healthy bowel with a good blood supply, and also to remove some portion of the infiltrated and distended bowel wall above the constriction. There is no need to remove a deep " V " of the mesentery. The resection having been performed, it is wise to allow the upper portion of the bowel to empty itself into a dish for a minute or so, and an anastomosis is then performed by either the end-to-end or side-to-side methods described on pp. 701, 702.

A few cases will be seen where the condition of the patient is so desperate that he would not stand the shock of a resection and anastomosis, however quickly done, and then it may be necessary to divide the constriction, drag down the damaged bowel, and either open it and leave it in situ so that its contents may drain away, or else cut it away and tie Paul's tubes into both opened ends. After the bowel has been allowed to drain in this way for some days, if the patient survives, which is unlikely, an anastomosis of the divided ends will have to be performed. Among other things, this method is open to the great objection that the profuse discharge of small intestinal contents will digest the surrounding skin rapidly and quickly lead to starvation of the patient.

In the case of all these operations, except the last, the procedure will be completed by closing the neck of the sac and performing a radical cure as indicated on pp. 590, 600, 604. It must be admitted, however, that radical cures performed at the end of operations on herniæ which are strangulated are not as a rule satisfactory, owing to the stretching and infiltration of the tissues and the damage which has been done in relieving the constriction, so that recurrence is very likely.

After-treatment. The after-treatment of such a case will depend naturally upon whether bowel has been removed or not and, as in all cases of intestinal obstruction, it is of the greatest importance. The treatment of cases of obstruction after operation will be discussed in general in Chapter XVI., but stress should be laid upon the fact that both collapse and toxæmia probably will require treatment. The treatment of the former is described in Vol. I., Ch. IV., while the latter is best relieved by providing the patient with plenty of fluids. For the first twenty-four hours these are best given by the rectum, while small quantities also may be given by the mouth, and, in addition to this, the patient's bowels should be encouraged to act as soon as possible. This is best accomplished by injections of pituitary, and turpentine, or soap and water enemata given about thirty-six or forty-eight hours after the operation. Opiates should be avoided if possible, but if the pain is great morphia or heroin may be used.

Complications and Sequelæ. The complications following this operation are, in general, those which may follow any other abdominal operation; thus excessive vomiting, retention of urine, chest complications, infection of the wound (especially the last), will be seen and are treated as in Ch. V., Vol. I.

(1) In some cases it will be found that the symptoms of obstruction, as shown by persistent vomiting becoming fæculent, distension, pain, rising pulse rate and general toxæmia, persist after the operation. In most cases this is due to a *paralytic condition of the small bowel*, the muscle wall becoming paralysed and distended and unable to transmit its contents. This is a grave condition, and every effort must be made to get the bowel to act by means of injections of pituitary or eserine, by enemata, or if the vomiting is not too severe by the administration of calomel followed by a saline draught; washing out the stomach or continuous suction through a nasal catheter passed into the stomach or duodenum, will also be of assistance, while in all such cases saline with 5 per cent. glucose should be given by intravenous drip. Administration of antigas-gangrene serum has proved very valuable in some of these cases, as the toxæmia and intestinal paralysis are often due to the toxins of B. welchii, as also does the treatment by bile described on p. 538. If the condition is due simply to paralysis of the bowel, this treatment may succeed, but if there is an actual obstruction from adhesions, kinking, or from the onset of gangrene following the operation, it cannot do so; all these causes of true obstruction after operation are, however, rare. If relief is not maintained by the above measures, the question

of whether the abdomen whould be opened again in an effort to obtain benefit is a grave one. Many surgeons strongly advocate opening the abdomen again on the first sign of paralysis of the bowel and forming an enterostomy to drain its contents. We personally are opposed to this unless there is definite evidence, as shown by pain, visible peristalsis and increased peristaltic sounds on auscultation, that an organic obstruction and not a paralytic ileus is present. Should it become necessary to open the abdomen a second time, the patient's condition probably will be exceedingly bad, and in most cases all that it is possible to do will be an enterostomy; this should be done as high up as possible.

(2) Another complication arising soon after the operation consists in *general peritonitis* from perforation of the damaged bowel, or even occurring as a result of infection of the bowel wall without actual perforation. This is a desperate condition, demanding opening of the abdomen and suture or removal of the damaged coil.

(3) A condition of *acute enteritis* is sometimes seen to occur, presumably affecting the part of the bowel damaged in the hernia and that just above. This gives rise to diarrhœa, pain, rise of temperature and vomiting, with the passage of mucus and even blood in the stools. The condition usually sets itself right in a few days, and is assisted by reducing the diet to a minimum and giving small doses of opiates.

(4) Apart from suppuration in the wound, which is common from the infected fluid in the sac, the onset of a *localised peritonitis* with the formation of an intraperitoneal abscess is sometimes seen, as the result of an infection passing through the bowel wall. Such an abscess must be opened as soon as possible, and will be found to contain brown, stinking pus. When this occurs it sometimes will be found that, after the abscess has been opened, a *fæcal fistula* will form, and recognisable intestinal contents escape, though the brown, stinking pus must not be mistaken for this. Such a fæcal fistula is due to the bowel wall giving way, probably at the site of constriction, or possibly from the pressure of a drainage tube, and, though the condition is primarily within the peritoneum, the danger of peritonitis is avoided by the previous formation of adhesions. The appearance, signs and symptoms of such a fæcal fistula are those of a fæcal fistula anywhere else, as described on p. 675. The majority of such fistulæ following herniæ close spontaneously.

It must be remembered that an artificial anus, as made by the surgeon in the course of an operation, differs from a fæcal fistula in that in the former a spur or other device is present which prevents any fæcal matter passing on into the bowel below the opening, and which thus diverts the whole fæcal stream through the external opening.

(5) A rare sequela of an operation for strangulated hernia is the formation of a *fibrous stricture of the bowel*, which usually occurs at the site of one or both of the constriction grooves, where the intestine was strangulated. This is due to the formation of fibrous and scar tissue, produced in the healing of the ulceration which has occurred at this spot, so that the condition is not likely to come on for at least a month, and probably more, after the operation. Its signs and symptoms are those of a subacute incomplete obstruction coming on gradually and giving rise to borborygmi and colicky pains with visible peristaltic coils. A full description of this condition, with its treatment, will be found on p. 667.

Having described the complications to which any hernia is liable, we will now proceed to discuss the different anatomical varieties of hernia. The following description applies almost entirely to uncomplicated, reducible herniæ, except where otherwise stated.

INGUINAL HERNIA

An inguinal hernia is the term given to a hernial protrusion which occurs in the neighbourhood of and close to the inguinal canal, the hernia in most cases actually passing down the inguinal canal, and leaving that canal through the external inguinal ring. There are two main varieties of inguinal hernia, the *oblique or indirect*, and the *direct inguinal hernia.*

(A) **Oblique or Indirect Inguinal Hernia.** This leaves the abdomen through the internal inguinal ring, above and to the outer side of the deep epigastric artery, and passes down inside the inguinal canal to leave it at the external inguinal ring, whence, if it increases still further, it enters the scrotum. If the hernia descends into the scrotum (or the labium in the female), it is termed *scrotal, labial or complete,* while if it only reaches as far as the external inguinal ring it is known as a *bubonocele or incomplete hernia.* Inguinal herniæ are by far the commonest form seen.

Surgical Anatomy. The inguinal canal, reaching as it does from the internal to the external abdominal ring, is about 1½ inches long and slopes downwards, forwards and inwards. Its anterior wall is formed by the aponeurosis of the external oblique, in which the opening known as the external ring lies, the pillars of this opening being strengthened and reinforced by the intercolumnar fibres; the upper part of the anterior wall of the canal is reinforced by the fibres of the internal oblique arising from Poupart's ligament. The posterior wall of the canal is formed throughout by the transversalis fascia and for its inner half also by the fibres of the conjoined tendon just before they blend with the sheath of the rectus. The roof is formed by the fibres of the internal oblique and transversalis muscles arching over the canal, and the floor by the upper surface of Poupart's ligament, and to a certain extent also by Gimbernat's ligament. The deep epigastric artery lies immediately below, and to the inner side of the internal abdominal ring. Immediately below the upper and outer end of the inguinal canal, and separated from it only by Poupart's ligament, lie the external iliac artery and vein. It will be seen that when the abdominal muscles contract, and strain is put upon the inguinal canal, the arched fibres of the internal oblique straighten out and descend so as to obliterate the inguinal canal and fortify its posterior wall.

The inguinal canal contains the spermatic cord and the round ligament in the two sexes respectively, together with the ilio-inguinal nerve and the genital branch of the genitocrural nerve. As an oblique inguinal hernia passes down the canal it pushes before it a series of layers of tissue which represent the different layers of the abdominal wall; these are known as the *coverings* of the hernial sac, and in a fully-developed hernia are more or less completely fused together and unidentifiable. Thus the coverings of an oblique inguinal hernia from without inwards, which the surgeon will have to divide in exposing and cleaning the sac, are as follows: Skin, superficial and deep fascia, the intercolumnar or *external spermatic fascia,* which represents the transverse fibres of the external oblique reinforcing the external ring, the *cremasteric fascia* and muscle, which is a direct continuation of the internal oblique, the infundibuliform or *internal spermatic fascia,* which is a prolongation of the fascia transversalis; and, finally, the extraperitoneal fatty and areolar tissue. The cremasteric layer is the only one of these which almost always can be recognised.

It will be seen, therefore, that in the oblique inguinal hernia the neck of the sac is always to the outer side of and close to the deep epigastric artery, while the structures of the spermatic cord are usually attached to and spread over the sac.

A *direct inguinal hernia* does not enter the inguinal canal by the internal abdominal ring; it leaves the abdomen to the inner side of the deep epigastric artery and passes out through the external ring (see p. 584). Two varieties are described, according to whether the hernia passes out (*a*) to the outer side of the obliterated hypogastric artery, *i.e.*, through the floor of Hesselbach's triangle, or (*b*) to the inner side of this artery and then through the floor of Hesselbach's triangle and through the conjoined tendon.

Several different anatomical types of oblique inguinal hernia are recognised.

(1) **Congenital Inguinal Hernia.** The testicle during its descent into the scrotum drags down with it an outgrowth or diverticulum of the peritoneum, which more or less surrounds the developing testicle with a double bag or sac in the same way in which the pleura does the lung, or the peritoneum does the abdominal viscera. This diverticulum is known as the *processus vaginalis*, and normally its upper portion should become obliterated at or before birth, only a fibrous cord remaining to mark its site, while the lower portion of the processus persists and gives rise to the tunica vaginalis. It is only in man that this closure of the processus vaginalis occurs, even in the monkey it always remains patent. It not infrequently happens that this obliteration of the processus vaginalis does not occur at all, so that a peritoneal lined tube is present leading directly from the peritoneal cavity to the tunica vaginalis and forming a preformed sac, into which abdominal contents may at any time descend, when they will pass right down into the scrotum, and

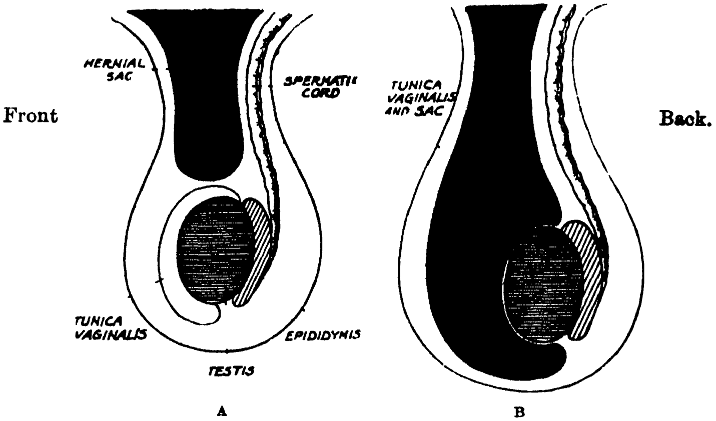


FIG. 196 (A) Ordinary acquired inguinal hernia. (B) Congenital inguinal hernia.

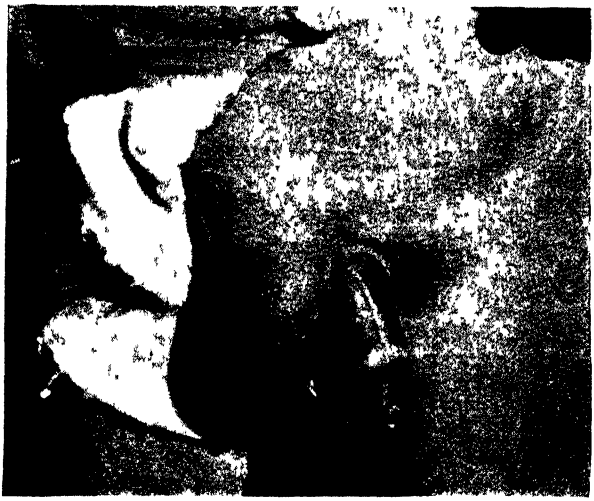
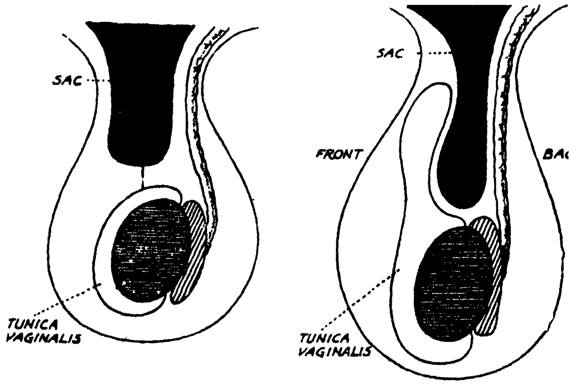


FIG. 197. Congenital right inguinal hernia

come to lie in contact with and round the testicle. This is known as a *congenital hernia.* This does not mean that the hernia is necessarily present at birth, or even in infancy, and in many instances the hernia does not appear until adult life. It is much more common on the right side than the left, as the right testicle descends later, and, as a rule, when it first appears it immediately passes right down to the bottom of the scrotum and becomes complete. Its first appearance is not infrequently accompanied by strangulation, while one or more fibrous constrictions in the sac at different levels, which probably represent attempts at closure and obliteration of the processus, are usually to be seen, and these will render the strangulation unusually tight and the hernia unusually difficult to reduce. The sac of a congenital hernia is usually particularly thin and the structures of the spermatic cord firmly adherent to it.

It sometimes happens that the upper part of the processus vaginalis remains patent, but that the structure becomes closed for a short distance just above the testicle, and so shut off from the tunica vaginalis. The hernia may then descend into this upper unobliterated portion, and will resemble an acquired hernia closely, except that it becomes complete at once, has a very thin sac, often with fibrous annular constrictions in it and to which the structures of the cord are particularly adherent, while the lower end of the sac passes into a fibrous band which reaches down to the tunica vaginalis (sometimes known as the fibrous band of Cloquet). In this hernia the contents are not in contact with the testicle, and the condition is known as a *hernia into the vaginal or funicular process.* These two varieties of congenital hernia are sometimes known as the complete vaginal congenital hernia and the incomplete funicular congenital hernia respectively.



A B

FIG. 198. (A) Hernia into the funicular process. (B) One type of infantile hernia.

In the female it is probable that all inguinal herniæ are congenital; there is an elongated process of the peritoneum similar to that which occurs in the male and known as the canal of Nuck, which accompanies the round ligament and should normally be obliterated before birth. In some cases this remains patent, and then a hernia may descend into it at any time.

(2) **Infantile Hernia** (*Encysted Hernia*). This is a rare type of hernia, which can be recognised only at operation. It is thought to be due to the funicular process becoming shut off from the abdominal cavity at the top only, in the neighbourhood of the internal ring, while it remains patent below and communicates with the tunica vaginalis, which thus appears to extend right up

into the inguinal canal. A hernia then forms with a separate sac, and this sac may pass down behind or in front of the elongated tunica vaginalis, or may invaginate it. The accompanying diagrams will make this clear. The condition in which the sac passes behind the tunica vaginalis is the least uncommon. It should be noted that the condition is usually seen in adults, so that the term " infantile " does not refer to the age of the patient, while the condition may be accompanied by an undescended testicle. Another theory of the origin of this condition is that the hernial sac represents an unobliterated portion of the processus vaginalis, and that during the descent of the testicle a portion of the peritoneal process gets caught up and fixed at some point in the inguinal canal, this forming the apparent upward elongation of the tunica vaginalis.

In operating upon one of these herniæ the surgeon, on opening what appears to be the sac, finds himself in a peritoneal lined tube, which passes downwards to the testicle and upwards for some distance, but does not communicate with the abdomen, and at the back of it what appears to be an enlarged spermatic cord can be seen. In order to find the true sac he will have to proceed further and cut through either one or two more layers of peritoneum, according to whether the type of hernia illustrated in Fig. 198 or 199 is present. The apparently enlarged spermatic cord is due to the fact that it contains the real sac.

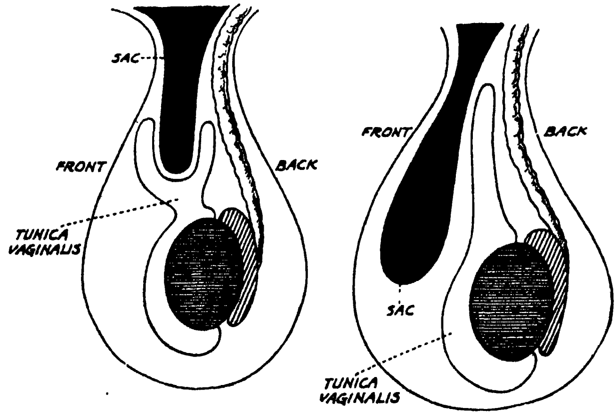


FIG. 199. The two other types of infantile hernia.

(3) **Acquired Inguinal Hernia.** As has been discussed already on p. 566, it is doubtful whether any oblique inguinal hernia is ever acquired. If so it would be due to the gradual pushing out of the sac of peritoneum down the inguinal canal without any preformed space being present.

(4) **Hernia with an Undescended Testis.** This is an exceedingly common combination in children, in fact it may be said that any case of undescended testicle has also a potential hernial sac. Commonly the testicle will be found somewhere within the inguinal canal, but it may be retained within the abdomen (see p. 935). The hernia is naturally of the congenital variety and resembles this in all its features, though the presence of the undescended testicle will render both diagnosis and operative treatment more difficult.

The various forms of interstitial hernia sometimes occur in connection with malposition or imperfect descent of the testes (see p. 587).

(5) Cases of inguinal hernia are sometimes seen which appear on the right side some months after an operation for appendicitis; these are doubtless

due to weakness or wasting of the muscles in the inguinal region, as a result either of actual damage to the muscle tissues or more probably of damage to or involvement in scar tissue of the nerves which supply them, especially the iliohypogastric nerve and other branches of the twelfth dorsal and first lumbar nerves.

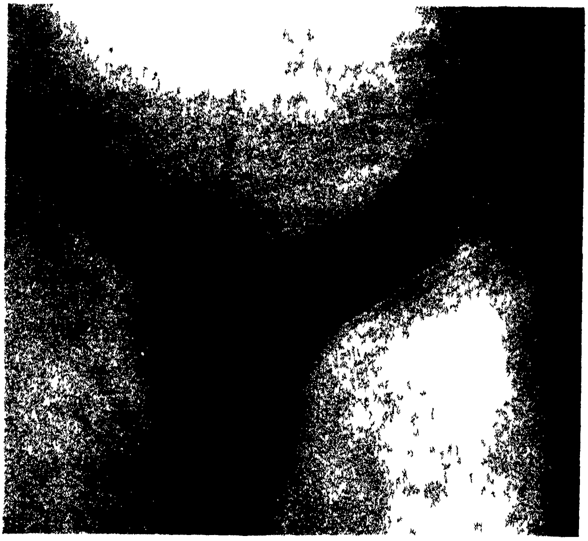


FIG. 200. Left inguinal hernia and undescended testes

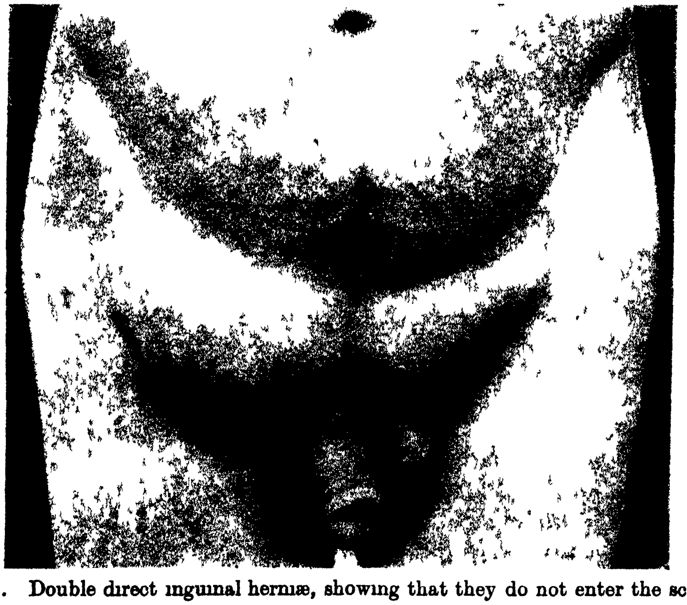


FIG. 201. Double direct inguinal herniæ, showing that they do not enter the scrotum.

(B) **Direct Inguinal Hernia.** In this hernia the contents, although they ultimately pass out through the external abdominal ring, do not pass the whole way down the inguinal canal, nor do they leave the abdomen through the internal ring. These contents bulge out to the inner side of the deep epigastric artery, which is therefore wrapped round the outer side of the neck of the sac. They force their way through the lower part of the conjoined tendon, thus entering the lower part of the inguinal canal and passing out through the external ring, traversing the space known as Hesselbach's triangle, this being bounded by the outer border of the rectus (the semilunar line), the deep epigastric artery and Poupart's ligament. Across this space there runs the obliterated hypogastric artery ; if the hernia bulges out above this vessel it is known as an *external direct hernia*, while if it passes below and inside this vessel it is an *internal direct hernia.* It will be seen, therefore, that the deep epigastric artery lies outside a direct and inside an indirect or oblique inguinal hernia.

The coverings of a direct inguinal hernia are much the same as those of an indirect one, except that the cremasteric covering is very much less marked and there is no layer representing the internal spermatic fascia ; in place of this covering there is a layer of tissue which represents the stretched and expanded conjoined tendon. The spermatic cord usually lies to the outer side of the hernia and is not spread out over it in the same way as over an indirect hernia (Fig. 201).

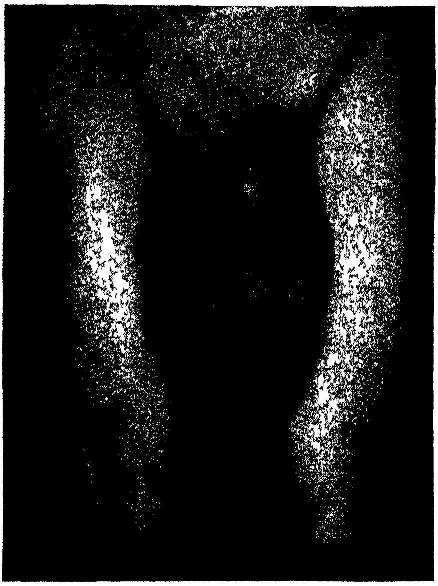


FIG. 202. Large left inguinal hernia and smaller right inguinal hernia.

These herniæ are never congenital, are usually small bulges, and *never pass down into the scrotum;* they do not occur in young people, but are usually seen in males of over forty, more commonly on the right side; they are, however, frequently bilateral. It usually can be noticed that the hernia on reduction passes directly backwards, while the opening in the abdomen appears to be large and round, so that the protrusion takes the form rather of a diffuse bulge than a tubular projection. These herniæ rarely strangulate for this reason, and if they do so the strangulation is not as a rule very tight. It must not be forgotten that after an indirect or oblique inguinal hernia has been present for many years, as the sac swells and enlarges the internal ring tends to pass downwards and inwards, so that it may come to lie behind the external ring, and thus the hernia will come to resemble a direct hernia, as it now bulges more or less directly outwards, but such a hernia is usually scrotal.

As direct inguinal herniæ have no real connection with the inguinal canal, they are by some authorities described as "herniæ through the linea semilunaris."

Clinical Signs and Symptoms of an Inguinal Hernia. In the early stages such a hernia appears as a small bulge in the neighbourhood of the internal ring, probably only noticeable when the patient stands up or coughs, and until the hernia becomes quite large, the pubic spine can be felt to be below and outside the swelling. This is an important point in distinguishing it from a femoral hernia. When small the hernia and its impulse will be detected best and the size of the rings ascertained by invaginating the scrotum with the finger, which may be passed gently up into the inguinal canal behind the cord. The swelling is bigger when the patient is standing up and tends to disappear or get smaller when he lies down. All the characteristic signs and symptoms of a hernia in general will be present (see p. 567). As it increases in size and passes down towards the scrotum, the swelling tends to become pyriform, and usually lies in front of and above the testicle, with the structures of the cord spread out behind it; the swelling will be accompanied by a fulness along the course of the inguinal canal. When the hernia becomes fairly large and presents in the form of a scrotal swelling, it may be distinguished from a hydrocele or any form of testicular swelling by grasping the upper part of the scrotum with the fingers behind and the thumb in front. If the fingers and thumb can then be made to meet above the swelling with nothing between them but the skin and spermatic cord, it is perfectly certain that the swelling does not descend from the abdomen and is not an inguinal hernia (p. 957).

The condition is commonest on the right side, but many cases are bilateral and the condition is most commonly seen in the male, the oblique variety being commonest in young people and infants. In the female, especially in young girls, it is not uncommon (see p. 566), and there it accompanies the round ligament and descends into the labium, where it may resemble a hydrocele of the canal of Nuck or a labial cyst or abscess.

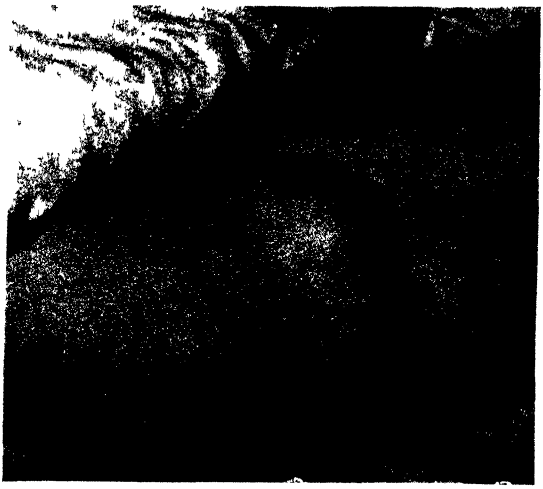


FIG. 203. Iliac abscess bulging above Poupart's ligament.

It may be difficult to be certain whether a small hernia is direct or indirect; in a few cases it is possible, by invaginating the scrotum, to feel on which side the deep epigastric artery lies, and this will settle the question.

It should be remembered that a hernia is opaque on transillumination, but this is not a reliable test, as small herniæ in young children may be translucent.

Differential Diagnosis. This is important, as there are many conditions which resemble an inguinal hernia.

(*a*) When the hernia is incomplete and lying in the inguinal canal or the neighbourhood of the external ring, it may resemble a femoral hernia; from this it can be distinguished by the fact that an inguinal hernia tends to pass downwards and inwards towards the scrotum, lies higher up, and the swelling is above Poupart's ligament and above and internal to the pubic spine.

Enlarged glands are not likely to be sufficiently high up to resemble an inguinal hernia; they have no true expansile impulse on coughing, but are merely pushed or jerked forwards, nor have they the characteristic pyriform shape to which the neck of a hernia gives rise, nor do they emerge from the inguinal canal. Glandular swellings have usually a characteristic shape and appearance (see Vol. I., Ch. XI.).

An undescended testicle should be recognised by its shape, its characteristic sensation on pressure, and the fact that one side of the scrotum will be empty, while there is no impulse on coughing, unless a hernia coexists, which is a very common occurrence.

An encysted hydrocele of the cord in the canal is smooth, globular and tense, has no impulse on coughing, is freely movable, but irreducible, and becomes fixed when traction is made upon the testicle, while usually the finger and thumb can be made to meet above it.

It must be remembered that abscesses coming from within the abdomen are reducible (but without a gurgle), have a true expansile impulse on coughing, and may occasionally protrude through the external ring. They are, however, fluctuant, have no definite firm outline, while usually a cause for the presence of the abscess can be elicited. A congenital hydrocele gives rise to very similar signs (see p. 951).

Difficulty will arise occasionally in connection with tumours of fat or fibrous tissue arising within the inguinal canal and projecting downwards. There is, however, no true impulse on coughing, and the fingers usually can be made to meet above them. They are sometimes found to contain a hernial sac inside them.

(*b*) When the swelling has entered the scrotum it may bear a superficial resemblance to a hydrocele, varicocele, or a swelling of the testis or epididymis. Apart, however, from the characteristic signs and symptoms of these latter conditions, the test described above, in which the fingers and thumb are made to meet if possible at the upper part of the scrotum, will determine at once whether the swelling arises within the scrotum and ascends towards the inguinal canal or descends from the abdomen and inguinal canal into the scrotum (Chapter XXI, p. 957).

It must not be forgotten that an inguinal hernia frequently coexists on either one or both sides with other scrotal swellings, such as a hydrocele or varicocele.

Interstitial Inguinal Hernia. This is a rare form of hernia, where a sac is found lying in between one or other of the layers of the abdominal wall, it is a frequent complication of a malplaced testis. There are at times two or more sacs which open into the abdomen by a common neck or opening, and one of which may occupy the usual position of an inguinal hernia and may actually descend into the scrotum. The interstitial sac or portion of the sac may be found in one of three situations:—

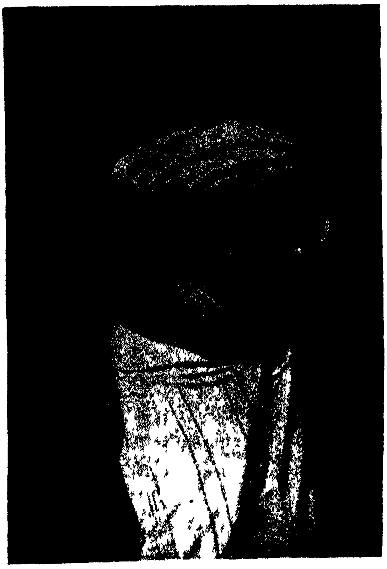


FIG. 204. Interstitial inguinal hernia.

(1) In front of the peritoneum and behind the transversalis fascia: this is known as the *intraparietal or properitoneal hernia.* Should a normal inguinal sac coexist, the condition

is sometimes known as a *hernia en bis sac.* The interstitial portion of the sac may lie between the symphysis pubis and the bladder, may pass backwards towards the iliac fossa or sometimes passes upwards and outwards towards the anterior superior iliac spine. The importance of this rare form of hernia is due to two facts: (*a*) that it may produce no external, palpable or visible swelling, and in that case it may become strangulated without its existence being recognised; and (*b*) should the inguinal portion of the sac become strangulated, and taxis be employed, a false reduction may occur, and yet the symptoms of strangulation continue, owing to the bowel having been really pushed backwards into the interstitial portion of the sac, the strangulation at the neck remaining unrelieved (see p. 574).

(2) The interstitial portion of the sac may lie between the internal and external oblique muscles: this is the least uncommon form, and is known as the *interparietal hernia.* The sac tends to pass upwards and outwards along Poupart's ligament and, when occupied, gives rise to an easily visible and palpable swelling in this situation.

(3) Occasionally the interstitial sac lies between the external oblique muscle and the skin, passing outwards through the external ring and then upwards parallel to Poupart's ligament. This is known as the *extraparietal hernia.* A visible swelling occurs which may resemble a femoral hernia.

All these unusual forms of inguinal hernia are often accompanied by a malposition or incomplete descent of the testicle, which often is found to lie in close proximity to the situation of the interstitial sac (see also p. 935). The causes of the condition therefore may be regarded as the same as the causes of malposition of the testicles (see p. 935).

Inguinal Hernia in Children. This condition is common in children, especially in boys, in whom it is usually of the congenital type. It is more common on the right side, frequently bilateral, and often associated with an undescended testicle. Such conditions as worms, phimosis, whooping cough, diarrhœa and flatulence undoubtedly increase the tendency for the bowel to pass down into the preformed sac. Irreducibility and strangulation do not occur often, but it is not unusual for the condition to be accompanied by a congenital hydrocele or encysted hydrocele of the cord.

In female children the ovary or Fallopian tube is often present in the sac.

Treatment. The treatment of an inguinal hernia consists either in a radical operation for its cure, or in relief by means of a truss; these methods must be supplemented by measures directed to the relief of any predisposing conditions such as chronic cough, stricture, phimosis, enlarged prostate, constipation, etc. There is no doubt that in nearly all cases operation is the more satisfactory treatment, though there is a recurrence rate of 3 per cent. to 5 per cent. in healthy persons, and one considerably higher in elderly and obese patients (20 per cent. to 30 per cent.).

(A) **Operative Treatment.**

1. *In Adults.* The radical cure of hernia by operation is undoubtedly the method of choice, and its results are excellent if the cases are carefully selected and the operation properly performed. The mortality is negligible. In children and young adults it is undoubtedly the best treatment, as they will be relieved of the expense, necessity, and discomfort of continually wearing a truss and from the possibility of strangulation. It is practically essential that it should be performed in adolescents who are entering any of the public services, who are going abroad, or who wish to indulge in athletic pursuits or lead a strenuous life. In older persons, however, the operation can be

regarded more or less as a luxury operation, although it is one which gives considerable relief in not having to wear a truss, and if successful does away with the chances of strangulation. Considerable judgment is therefore required in the selection of the older cases, and in many instances the choice more or less can be left to the patient. It must be remembered that the older the patient is the less is the chance of a permanent success, and though all factors must be taken into account, such as the patient's age, work, constitution, position, mentality, etc., there are not many patients over sixty on whom the operation should be done. Thus in middle-aged people, who do not lead strenuous lives, whose hernia is reducible and completely controlled by a truss, an operation is not a necessity, though they may well prefer to have it done in order to get rid of the truss. On the other hand, strong, muscular people who wish to lead strenuous lives will be rendered much more comfortable if a radical cure is performed, while in the case of the manual worker and the hospital type of patient a radical cure is all the more desirable, as he cannot attend properly to the supply of a suitable truss and may not be able to do his work in it.

There are, however, certain very strong contra-indications to operation :—

(*a*) Constitutional disease, such as phthisis, diabetes, chronic nephritis, tabes, etc.

(*b*) The presence of chronic cough, persistent straining on micturition or defæcation, and predisposing conditions of this kind.

(*c*) In enormously large irreducible hernia, where it is unlikely that the abdomen will be able to contain the contents ; for here the operation will be difficult, perhaps impossible, and the increase of abdominal pressure should the contents be reduced will lead almost certainly to rapid recurrence.

(*d*) In the case of direct herniæ, or patients in whom the whole of the abdominal musculature is weak and bulging, more especially if marked visceroptosis is present.

On the other hand, there are certain features which render the demand for operation greater, and they are the presence of pain and symptoms from the hernia, the presence of a hernia which is irreducible, the recurrence of mild attacks of semi-strangulation, the coincidence of an undescended testis or hydrocele, and a hernia which a truss will not control.

The most favourable type of hernia for operation is a long, narrow congenital oblique hernia in a young adult.

In the operation for a radical cure of an inguinal hernia there is one general principle which should underlie all methods, and that is that *the sac, right up to and including its neck, must be completely obliterated and removed.* This entails ligaturing the neck of the sac as high up as possible. The second principle, about which there is less unanimity, is that the weak spot afforded by the inguinal canal must be strengthened and closed by some method of muscle suturing, which still leaves room for the spermatic cord to pass out undamaged. Those who believe in the congenital sac as the origin of all herniæ hold that this muscle suturing is unnecessary, and there is little doubt that in young people with sound musculature, and especially in congenital herniæ, removal of the sac without muscle sutures is sufficient. In older patients, however, it is undoubtedly wise, in addition to removing the sac, to try to reinforce the muscular wall in one of the ways to be described. Very many different operations have been devised for an inguinal hernia, but we shall describe only a few of those most commonly in use.

In the case of a double hernia it is found that the likelihood of a recurrence is considerably less if the two sides are not operated upon on the same occasion.

Bassini's and Foster's Operations. These two operations are exactly identical, with the exception of one small step, and are undoubtedly the two most commonly performed. The necessary preparations having been completed, a 4-inch skin incision is made parallel to the inner half of Poupart's ligament and about ½ inch above it, exactly in the line joining the anterior superior spine and the spine of the pubes. The skin, superficial and deep fascia are cut through, the superficial external pudic artery, and a branch of the superficial circumflex iliac, together with several large veins, being cut and tied. The aponeurosis of the external oblique is then identified and cleaned, and the external ring in it exposed. The external oblique is then incised through the length of the incision; if wished, this incision may be carried right down into the external ring; if preferred, it may terminate short of the ring. The two edges of the aponeurosis are then separated from the tissues underneath, so that Poupart's ligament below and the fibres of the internal oblique and the conjoined tendon above are clearly displayed. The spermatic cord will then be seen, and the sac, which lies in the middle of it, must be identified by teasing apart the structures and coverings of the cord; the sac will be identified by its white, shining appearance, and often by noting its rounded border near its fundus. This may be very easy or very difficult to do, according to whether the sac is thick or thin, adherent or free. Stress should be laid on the fact that it is much better to do this procedure by clean dissection with a knife, and not by tearing or stripping the tissues with the fingers or gauze. (This is a rule applicable to the whole of operative surgery.) Once the sac is identified it must be cleaned of its coverings right up to its neck, and this is usually rendered easier if the sac is deliberately opened and a finger passed inside it, while great care must be taken not to damage the vas or the spermatic artery and veins. At some stage during the cleaning of the sac it is essential to open it and pass a finger up into the abdomen, in order to be certain that there are no structures within it before it is tied and cut away. Likewise the finger should be passed down in the sac to see how far it goes and whether it passes right down to the testis (congenital hernia). Should any contents be present, if the hernia is reducible, they must be reduced within the abdomen. If it is irreducible, adhesions must be set free, and the bowel, if adherent, carefully separated and reduced. Omentum in a hernial sac, whether adherent or not, may be removed by being tied in separate small bunches and then cut below the ligatures. Bleeding from the cut omentum after reduction into the abdomen is by no means uncommon, and may be very serious.

The sac is then cleaned right up to its neck, and while doing this it must be remembered that if the sac is dragged upon unduly, the bladder will be drawn into the wound and may be damaged. The neck of the sac is then transfixed with a silk ligature and tied and the lower part of the sac cut away about ½ inch below the ligature. When the ligature is cut the ligatured portion should retract upwards out of sight.

Many surgeons rest content with this and make no attempt to approximate the deeper structures, and we advocate this reinforcement being done only when the muscles are weak or atrophied. It is never necessary in children.

Otherwise the inguinal canal is reinforced by stitching the conjoined tendon to Poupart's ligament with three or four interrupted catgut sutures, and at this point the two operations differ, for in Bassini's operation the spermatic cord is held up and the two layers are sutured behind the cord, whereas in Foster's operation the spermatic cord is allowed to drop back and is depressed, while the two layers are sutured over the cord. In our opinion, Foster's operation has a distinct advantage, as the cord is replaced in its natural position, and is less likely to be strangulated or unduly constricted if the suturing is rather tight. In order to pass these stitches through the deeper parts of Poupart's ligament the lower margin of the incision in the external oblique must be held up, when the ligament will be seen, and in passing these stitches it must be carefully remembered that the iliac vessels lie immediately underneath, and the vein especially is easily damaged. The external oblique aponeurosis is then sutured together, the external ring being reduced in size by the sutures so that the passage of the spermatic cord is just permitted, and the skin is sutured in the ordinary way.

In the female the operation is much easier—there is no spermatic cord, the round ligament can be ignored, and the external ring and canal completely closed.

Subperitoneal lipomata are fairly frequently found in connection with the sacs of inguinal herniæ, and unless these are carefully removed recurrence is likely.

There are other operations, such as Banks', Kocher's, and Macewen's, in which the sac is either displaced, removed, twisted, or inverted, without incising the external oblique or exposing the canal. We cannot countenance any such operation, as we believe that a thorough exposure of the canal and of the neck of the sac is essential.

Minor alterations in the above operations exist; some surgeons make a practice in sewing up the external oblique aponeurosis of overlapping its two edges to the extent of ¼ or ½ inch. This is a sound procedure if the aponeurosis is lax and flabby. The Willys-Andrewes operation is of this nature.

Bloodgood's Operation. This is a rather similar operation, especially good where the abdominal walls are weak and poor, where the rings are large, or in the case of a direct or recurrent inguinal hernia. Here the operation is conducted in a similar way to Bassini's, except that instead of stitching the conjoined tendon to Poupart's ligament, the anterior layer of the rectus sheath is exposed, a flap of this is cut, turned downwards and outwards, and stitched down to Poupart's ligament across the canal, thus strengthening it and supporting it. Another variation of this operation consists in dragging the rectus muscle itself downwards and outwards and suturing it to Poupart's ligament at its inner end.

Treatment of Direct Hernia. The operative treatment of this condition is much less satisfactory, and few cases are really suitable for radical cure. Should it be done it will not be possible to tie the neck of the sac and cut it away, as the sac is usually a diffuse bulge. The sac must be opened, a portion cut away, and then be sewn up as would be the peritoneum in an ordinary laparotomy incision; the muscles are then brought together over the peritoneum, in the external variety by Foster's procedure, and in the internal variety by Bloodgood's method, little attention being paid to the spermatic cord.

In certain cases of direct hernia the use of a *filigree* of silver wire-netting is advisable; some surgeons advocate the use of two overlapping filigrees, but one large one is usually sufficient. The method of employing it will be described on p. 603.

Grafts of living tissue are employed in the cure of difficult herniæ; the graft is cut from the fascia lata and darned over the hernial aperture, using the strips of fascia as sutures, as advocated by Gallie. The graft is cut with a special graft cutter and the fascial sutures are inserted by means of special needles. It is essential for success that rigid asepsis be secured and that loose darning be employed, as if sutures are drawn tight they cut out and recurrence will follow.

Injection Treatment to secure obliteration of the sac by means of subcutaneous injections of sclerosing fluid around the neck has been advocated. This treatment can be carried out by weekly injections, the patient continuing his work but having to wear a tight truss day and night for three months, while cases of sloughing of the cord and testes, and subsequent recurrence and strangulation are reported.

After-treatment and Complications. After operation the wound should be dressed with a sterile dressing with a tight spica bandage to support the groin; it need not be redressed until the eighth day, when the stitches are removed, but care must be taken that the dressing is not soiled with urine, etc. The patient should stay in bed for a period of from twelve to eighteen days, according to his age and the condition of his abdominal wall. Some surgeons get the patients up in six or seven days. After this there should be at least three weeks' convalescence, when light work may be commenced, no heavy work, severe exercise, or marked strain to be indulged in for two months after the operation in the case of a young adult or six months in old people or direct herniæ. On no account should a truss be worn after operation unless signs of recurrence are appearing.

The complications of the operation are those of any other abdominal operation. Special mention should be made of retention of urine and of the fact that varicocele, hydrocele, atrophy of the testis, and epididymitis may follow within a few weeks from mild degrees of damage or constriction of the spermatic cord. Hæmatomata following the operation are not uncommon, and are due to imperfect hæmostasis: if one is forming the scrotum should be suspended on a sand-bag. They may become very large, but always will absorb in time. On no account should they be opened or interfered with.

2. *In Children.* In children if after a year's careful treatment with a truss the hernia is still present, and in all cases where the hernia is very large, and

uncontrollable by a truss, or where it causes pain or other symptoms, operation should be undertaken. This is done on exactly the lines described above, and the essential step is the ligature of the neck of the sac with removal of its fundus. It is not necessary to perform any suturing operation upon the muscles other than suture of the external oblique. The wound is best dressed afterwards with a collodion dressing tightly sealed down in order to prevent the child interfering with the wound with his fingers and to keep the urine from soiling it.

Should an undescended testicle also be present, this should be dealt with at the same time (see p. 935). It must be remembered that in children the sac is thin, and often adherent to the spermatic cord, the structures of which are very minute and difficult to identify, so that great care must be taken not to damage the cord. A child need stay in bed only about six to ten days and can return to ordinary life as soon as he seems fit for it.

Tuberculosis of a hernial sac is sometimes seen in children with a tuberculous peritonitis, the sac being thickened and gelatinous and studded with tubercles on its inside. The thickening of the sac sometimes may be felt externally.

Congenital Hernia. There is only one way in which the operative treatment of this variety differs from that described above. The sac must be ligatured below as well as at its neck, the lower closed portion remaining to form the tunica vaginalis. The sac is usually thin and particularly adherent to the spermatic cord.

In *infantile hernia* the surgeon will be puzzled on opening what he thinks is the sac by finding that his finger will not pass up into the abdomen. The condition is described on p. 582, and a study of the anatomy will at once reveal what has occurred.

(B) **Palliative Treatment.**

1. *In Adults.* This consists in the wearing of a properly fitting truss, which by pressure upon the ring and inguinal canal should prevent the hernia descending. The apparatus consists roughly in a stiff, spring belt surrounding the lower part of the trunk, kept in place by certain straps and with a pad which presses upon the hernial aperture. The standard type of surgical truss is illustrated in Fig. 205, though a more recent and alternative form, possibly more comfortable for the patient, has an elastic band instead of the metal spring. In the case of scrotal and large herniæ the spring form is, however, essential. Many hybrid and patent forms are also on the market, which, in spite of their guarantees to cure rupture, are probably none of them as good as the standard type here illustrated. Slight variations in the shape of the pad and of the spring, and in the arrangement of the straps, will be necessary in different cases. A good and well-fitting truss is light, strong, perfectly comfortable, and should control the hernia in all positions and movements of the body; above all, it must not press too heavily upon the ring, or it may tend to enlarge the ring and increase the hernia; there should be no pressure

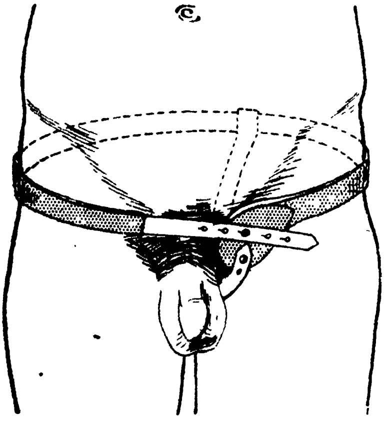


FIG. 205. Left inguinal truss.

on the pubic bone. When properly in position it runs round midway between the crest of the ilium and the top of the trochanter, and at the back runs across the middle piece of the sacrum.

To measure for a truss a tape is taken and passed round the body at this level, starting at the pubic spine and returning to this point: the tape must pass round the body midway between the great trochanter and the crest of the ilium; the number of inches in this length is the measurement of the truss. A truss is put on while the patient is lying down, before he gets up, and should be worn all day long while he is up and about, special rubber-covered trusses being available for use when bathing. In most cases it can be taken off at night unless he has a chronic cough. The size of the pad will depend roughly upon the size of the hernia and the ring. In some cases the soft part of the pad is prolonged downwards into a tail from which the understrap, which passes between the legs, projects; this is known as a *rat-tail truss*, and is especially suitable for big and scrotal herniæ. The shape of the pad also may have to be altered in the case of a direct hernia. Some surgeons advise the wearing of a double truss even for a single hernia. The double truss certainly is more comfortable, does not require understraps, and stays in position well. On the whole, there is no objection to this procedure provided the pads are big and do not press into the abdomen too deeply. It is possible that the continuous wearing of a truss in time will produce a cure in an adult hernia, though this is far less likely than in the case of a child's hernia, and it must be remembered that if the hernia once slips down, even for a few minutes, all the previous good will be undone, as the sac will become stretched and reopened again. It should be remembered also that once a truss is started, it must usually be worn for the rest of the patient's life, and a new truss will be needed about every two years, no small expense for a hospital patient. Trusses cannot be fitted on irreducible herniæ, or those which are accompanied by a hydrocele or an undescended testis.

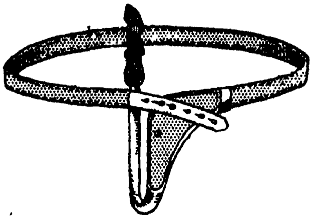


FIG. 206. Left inguinal rat-tailed truss.

2. *In Children.* In children it should be remembered that there is a distinct tendency for the hernia to disappear, if predisposing factors, such as straining, phimosis, etc., are got rid of, and the hernia can be kept continuously from coming down into its sac. A small child, however, cannot wear a truss of the ordinary type, but a hernia can usually, unless very large, be controlled by means of a skein of wool truss, which is fixed round the body and up between the legs, and presses upon the inguinal canal through the medium of a woollen pad. When the child is bathed or for any reason the apparatus is taken off to be changed, the hernia must be supported carefully by the fingers of the mother or nurse. If the hernia can be kept continuously up for a year or two by this means, there is quite a chance that the sac will become obliterated and the rupture disappear. In all cases in children where the control is unsatisfactory, and as soon as the child is over a year old, the hernia should be operated on. It must be remembered that many cases of apparent cure of a hernia in an infant by a truss are only apparent, *i.e.*, the sac remains patent, but as the child grows, the mesentery becomes relatively shortened and the bowel cannot get down into the sac. At a later age the hernia may then reappear.

Strangulated Inguinal Hernia. This is rather less common than strangulated femoral hernia, but by no means rare in the male. The stricture may be at the neck of the sac, or at the external ring, but is frequently at other situations, and is then caused by a fibrous ring in the wall of the sac. The signs and symptoms are characteristic, and are described on p. 572. *Torsion of the testicle or inflammation of an undescended testicle* may resemble the condition; there is, however, less vomiting and constipation, the pain is of the characteristic testicular variety and not griping, and the patient altogether less ill (see p. 932), while usually one or both testes are absent from the scrotum.

The operation is performed on the lines described on pp. 575, 590. Division of the stricture is best made by passing the knife in an upward and slightly inward direction, *i.e.*, parallel to the artery, as it may be impossible to tell beforehand whether the hernia is direct or indirect and, therefore, which side of the neck the deep epigastric artery lies. Gangrene is rare in a strangulated inguinal hernia, but should a resection be necessary it can be performed by enlarging the original incision upwards.

Strangulation is sometimes seen in children, but is usually not very severe, and the child complains chiefly of abdominal pain. A small child should be placed in a warm bath, when, after a short time, it is probable that gentle taxis will produce reduction, either with or without an anæsthetic. If this fails operation on the usual lines must be performed at once. Strangulation of an inguinal hernia is more common in infants under six months old than in older children.

Recurrent Inguinal Hernia. This is much less common than it used to be, and in a series of cases carefully selected, the recurrence percentage is very low, certainly under 5 per cent. If it is going to occur it is usually within the first eighteen months. There is no doubt that experience in the performance of hernial operations greatly diminishes the recurrence percentage; the cases done by house surgeons and inexperienced surgeons show more recurrences than those done by more experienced surgeons, though the method employed and the operative technique may appear to be identical; and it is probable that the difference lies in the thorough cleaning of the sac in order that it may be ligatured as high as possible. Should a deep suppuration occur in the wound, recurrence is likely.

If recurrence occurs, it is often in the upper part of the wound, while it may vary from a slight bulge to a complete recurrence of the hernia, which may be bigger than it was before. It is especially common after operations for strangulated hernia or direct hernia, and in elderly bronchitic subjects.

An operation for radical cure of a recurrent hernia is difficult, and not so likely to be successful as was the original operation. The layers are difficult to identify because of the scar tissue, and the muscles cannot be drawn together easily for the same reason. In many instances a procedure on the lines of Bloodgood's or Gallie's operations or the implantation of a filigree will be necessary.

FEMORAL HERNIA

A femoral hernia is one which leaves the abdomen by passing through the crural ring under Poupart's ligament into the crural or femoral canal at the inner side of the femoral vein. It then passes forwards through the saphenous opening of the thigh, where it becomes subcutaneous. After inguinal hernia, it is the commonest variety met with.

Surgical Anatomy. The crural or femoral canal is usually about ¾ or ½ inch in length and forms the inner compartment of the femoral sheath, containing generally a little fat, a lymphatic gland, and the lymphatics passing up from the lower limb. This canal is closed above by the crural ring, which is covered across by a thickened portion of the extraperitoneal tissues known as the septum crurale, while the lower end of the canal lies underneath the saphenous opening, which is covered over by the cribriform fascia. The crural ring, which usually constitutes the neck of a femoral hernia, is bounded in front by Poupart's ligament, behind by the pectineus muscle and pubic bone, on the inner side by Gimbernat's ligament and the conjoined tendon, and on the outer side by the femoral vein with one partition of the femoral sheath intervening. The spermatic cord therefore will lie just above and internal to such a hernia, while the deep epigastric artery runs up close to the upper and outer angle of the crural ring. In some cases the obturator artery arises from this vessel, this being known as an "aberrant obturator artery." When this occurs the obturator vessel usually runs between the sac and the femoral vein, but in a small percentage of cases (about 1 in 300 bodies) this vessel runs along the top of and then down the inner side of the neck of the sac, following the edge of Gimbernat's ligament. In this position it may be wounded in an operation for strangulated hernia (see p. 601).

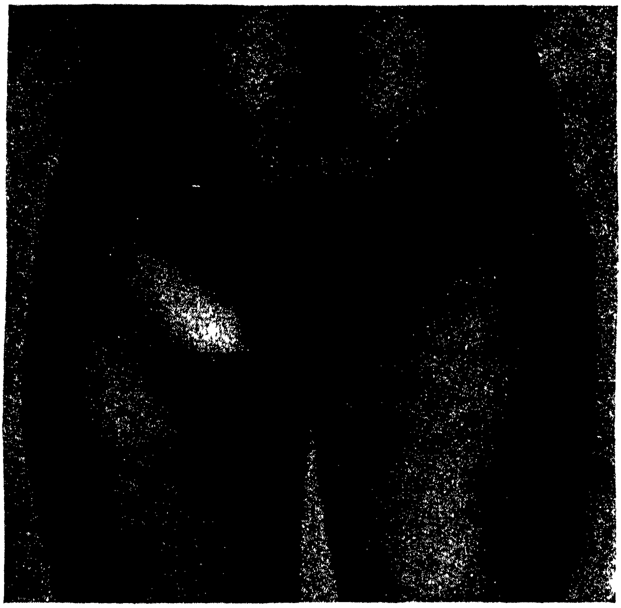


FIG. 207. Right femoral hernia.

The coverings of a femoral hernia will be, therefore, passing from the outside inwards, the skin, superficial and deep fascia, the latter in this situation representing the cribriform fascia, the anterior layer of the femoral sheath, representing the fascia transversalis, a layer representing the septum crurale and subperitoneal fatty tissue, and, finally, the sac itself.

It will be seen that a femoral hernia lies immediately adjoining the femoral vein, and pressure upon this vein may therefore be produced by it. After passing down the crural canal such a hernia bulges forwards, passing out through the saphenous opening, while, when it has emerged through this opening, the deep layer of the superficial fascia usually forces it to pass upwards and outwards along Poupart's ligament. In some cases it even bulges above the level of this ligament.

Femoral hernia is seen more commonly in women than in men, and especially in those who have borne children, for in this sex the space beneath Poupart's ligament is larger, the crural ring bigger, and Gimbernat's ligament less developed. It is probable that during labour the inguinal region is to a certain extent protected from strain, and this may account for the greater frequency of the femoral variety in multiparæ. On the other hand, femoral hernia in young people is more common in the male; the hernia usually contains small intestine, but omentum is not uncommon. Though femoral hernia is about three times as common in women as in men, nevertheless, even in women, the inguinal variety is the commonest. Women with femoral hernia tend to be fat, while men with the condition are usually thin. It is rare before puberty.

Fig. 208. Double femoral hernia.

Certain authorities hold strongly to the theory that even a femoral hernia is due to a congenital preformed sac, and allege that a pouch of the peritoneum may be dragged downwards by that portion of the gubernaculum testis which is attached to the neighbourhood of the groin. We do not, however, regard this as probable, and are of the opinion that a femoral hernia should not be regarded as congenital.

The sac of a femoral hernia is usually thin and only loosely attached to the surrounding tissues, while, should it become large, it tends to become loculated and to hang down the thigh.

There is a rare variety of this hernia in which the sac bulges into a space or cavity within the pectineus muscle; this is known as the *pectineal hernia of Clocquet.*

Other rare types are those (*a*) in which the protrusion lies behind Poupart's ligament and in front of the vessels; (*b*) where the hernia comes down outside the vessels in the neighbourhood of the ilio-psoas muscle; and (*c*) where it descends through an opening in Gimbernat's ligament. The first variety (*a*) is sometimes known as an inguino-femoral hernia (Nareth).

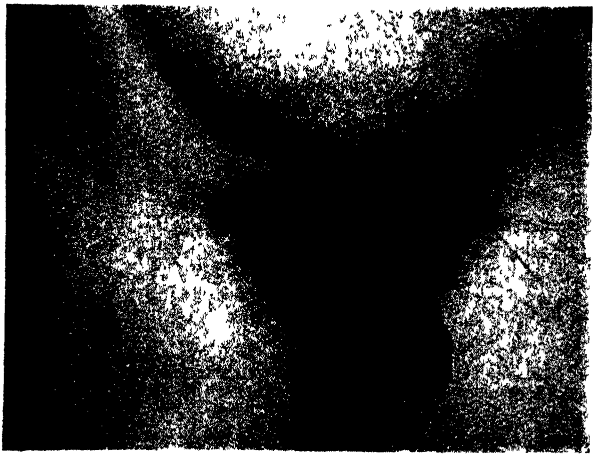


Fig. 209. Small right femoral hernia.

Clinical Features. Such a hernia forms slowly, and is often unnoticed for some time. Though very large examples are occasionally seen, they are commonly small and give rise to a swelling with all the characteristic features of a hernia (see p. 567), at the inner and upper part of Scarpa's triangle, with its neck or pedicle lying to the inner side of the femoral vessels and over the saphenous opening. The neck of the swelling, therefore, always lies below Poupart's ligament and below and outside the pubic spine. This will distinguish it from an inguinal hernia, but in fat people with large herniæ this distinction may be difficult to discover. It should be noted that the fold of the groin does not correspond with Poupart's ligament, but is below it. If reducible it will be noticeable that the contents pass first downwards, then backwards, and then upwards, and do not ever approach the inguinal canal.

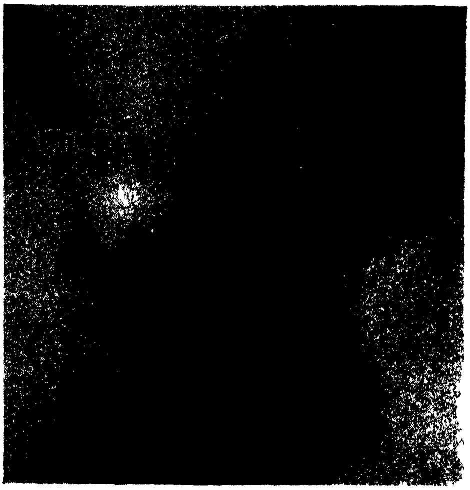


FIG. 210. Lobulated right femoral hernia. The scar of a previous radical cure can be seen on the left side.

It should be remembered that in a reducible femoral hernia, even when the contents are reduced and no swelling is present, the sac usually can be felt, and the presence of the hernia confirmed by pinching up the skin over the saphenous opening between the finger and thumb; this cannot be done in the case of an inguinal hernia.

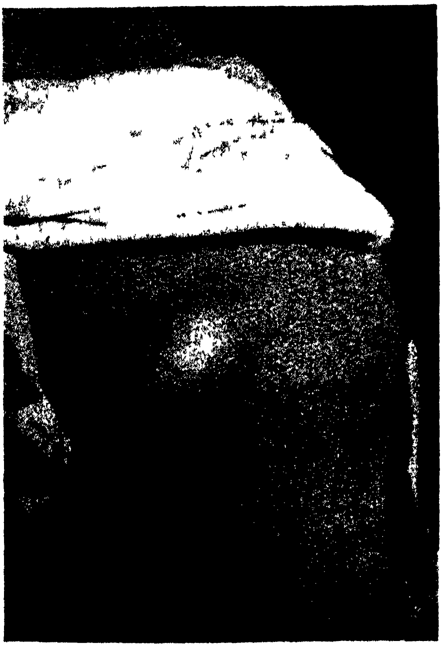


FIG. 211. Left femoral hernia.

Any of the complications of hernia described on p. 568 may be encountered. Irreducibility and the formation of a hydrocele of the hernial sac are not uncommon, while it is in the case of this hernia that Richter's and Littré's varieties are most commonly seen.

Differential Diagnosis. There are certain conditions in the groin which may closely resemble a femoral hernia. The methods of distinguishing it from an inguinal hernia have been described above, and are also referred to on p. 595, while it should be remembered that if the finger is passed both into the inguinal canal and into the saphenous opening the diagnosis always can be made.

(*a*) *Enlarged inguinal glands* are sometimes a cause of difficulty. They do not appear, however, as a rule, to have a pedicle passing into the crural canal, there is no impulse on coughing or resonance on percussion, while the outline of the individual fused glands is usually indicated by the rounded and lobulated feel of the swelling. Should the gland in the crural canal (Clocquet's gland) be enlarged and tender, diagnosis may well be impossible.

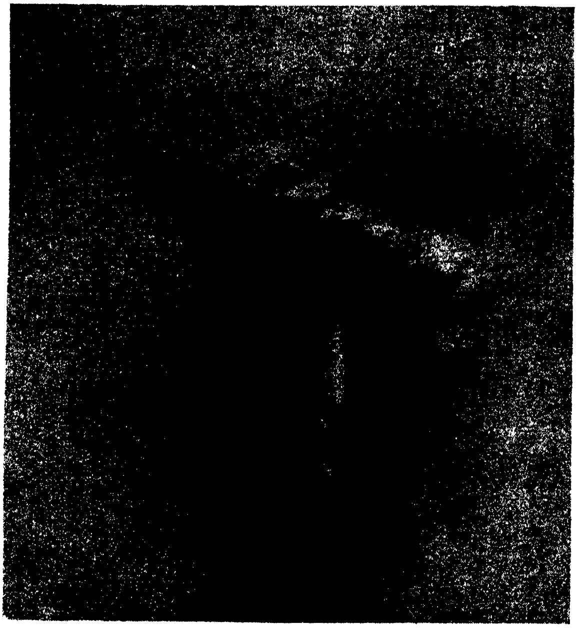


FIG. 212. Hypogastric varicosity and saphenous varix resembling small left femoral hernia.

(*b*) A *saphenous varix* sometimes will give rise to difficulty if close to the crural canal (Vol. I., Ch. X.). For this condition will have a form of impulse on coughing, will be reducible on pressure, and disappear when the patient lies down. It, however, can be noticed to fill up from below, while, in addition to an impulse, there is usually a thrill on coughing, varicose veins are present elsewhere in the limb, and the swelling feels remarkably soft and uniform.

(*c*) A *psoas abscess* occasionally presents at the saphenous opening, and this also will be reducible and have an impulse on coughing. The abscess, however, usually can be felt to pass behind and to the outer side of the vessels, while a swelling will be felt above Poupart's ligament, between which and the prominent portion at the saphenous opening fluctuation can be obtained. The signs of spinal caries nearly always will be coexistent.

(*d*) Enlargement of the bursa beneath the ilio-psoas, a lipoma in the groin (by no means uncommon), and a femoral aneurysm (possibly consolidated), bear only a very superficial resemblance to the condition and are not likely to cause difficulty.

Treatment. As already described above, treatment consists either in radical operation to produce a cure or in the fitting of a proper truss.

A femoral truss is very similar to an inguinal one except that the pad, instead of being placed on a direct prolongation of the spring, is situated lower down, attached to a down-turned portion of the truss itself. The pad is elongated downwards and should press directly backwards. The method of measuring for the truss is the same as in an inguinal hernia. Femoral trusses are rather more difficult to fit, and are, on the whole, rather less comfortable than inguinal trusses, as they may interfere with the movements of the limb; moreover, if badly fitting, they may press upon the femoral vein and give rise to œdema of the leg.

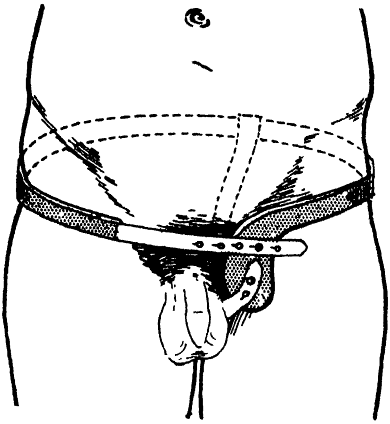


FIG. 213. Left femoral truss.

The selection of those cases which are suitable for operation and those which should be treated by a truss is made roughly in the same way as is already described on p. 592 in connection with inguinal herniæ, and the indications and contra-indications for operation are similar. It should be remembered, however, that a femoral hernia is undoubtedly a more dangerous form of hernia. Its neck is narrow and surrounded by the sharp and hard Gimbernat's ligament; strangulation is, therefore, particularly common and tight. These points, therefore, should make the surgeon even more inclined towards operation than in the case of an inguinal hernia, and femoral herniæ should be fitted with a truss only for very definite reasons. Irreducible herniæ, above all, are a serious menace if not operated upon.

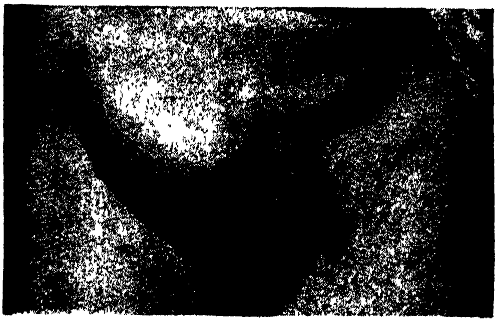


FIG. 214. Irreducible right femoral and reducible left inguinal hernia.

Operative Treatment. The general principles in the operation for the cure of femoral hernia are the same as those in the case of an inguinal hernia. The operation, therefore, consists first in exposing, cleaning and ligaturing the sac, and secondly, inasmuch as the sac is probably not congenital, in performing some suturing operation, in an attempt to close or obliterate the crural canal. There are two ways of exposing, cleaning, and ligaturing the sac :—

(*a*) In the old operation a vertical incision is made over the hernia, extending from 1 inch above Poupart's ligament downwards for about 3 inches. The sac is cleared of its coverings and is often found to be surrounded by extraperitoneal fat; its neck is cleaned as far as possible, and its contents reduced, any structures adherent within the sac being dealt with in the same way as described on p. 590. The neck of the sac is then transfixed and ligatured as high as possible, and the lower part of the sac cut away. Several different methods then may be practised for closing the crural canal. The simplest consists in passing two or three catgut sutures, or perhaps one mattress suture, through the inner end of Poupart's ligament, and through the pectineus muscle and the fascia over it, which lies immediately underneath the ligament. In this situation the stitches must be passed as deeply as possible right down to the pubic bone. In most cases this is sufficient, and a satisfactory cure of the hernia is obtained by tying Poupart's ligament down to the muscle underneath in this way.

An alternative operation consists in drilling the horizontal ramus of the pubis with two holes. A mattress suture is then passed through Poupart's ligament and through these two holes in order to tie the ligament down.

In all these methods great care must be taken not to damage the femoral vein with the needle and not to tie Poupart's ligament down so tightly that the femoral vein is compressed, or an œdematous leg will result.

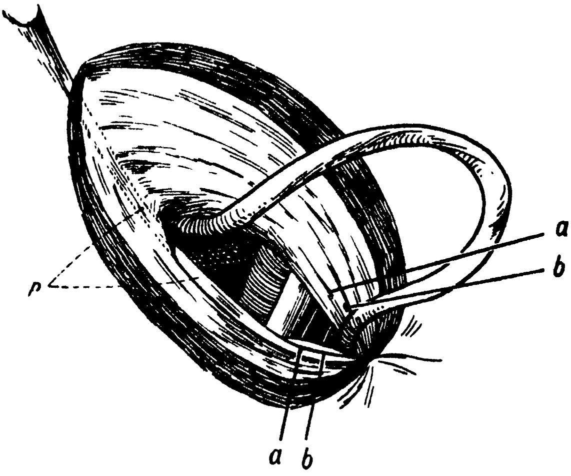


FIG. 215. Lotheissen's operation for radical cure of a femoral hernia. An incision is made above Poupart's ligament, the spermatic cord is lifted out of the way, the sac is found above the ligament and tied, and the conjoined tendon is sewn to Cooper's ligament by the stitches *aa*, *bb*. *p* = Poupart's ligament.

(*b*) All these operations performed below Poupart's ligament are open to the objection that the true neck of the sac lies about ½ inch above that ligament, and, therefore, cannot be satisfactorily approached from below. The more modern and more satisfactory operation is, therefore, to approach the sac from above Poupart's ligament by a skin incision parallel to and about ½ inch above its inner half, these operations being associated with the names of Battle and Lotheissen. By an incision keeping above Poupart's ligament the inguinal canal is opened; the cord or the round ligament is then lifted up, and underneath it the neck of the sac is identified and separated from the femoral vein, and the sac itself is drawn up from under Poupart's ligament, cleaned, ligatured at its neck and cut away, thus ensuring that it is ligatured as high as possible. The radical cure of the hernia then may be completed, either by one of the methods described above or by the method of Battle, in which the external oblique aponeurosis is incised outwards in a direction parallel to Poupart's ligament and ½ inch above it for 2 or 3 inches. The upper flap of the external oblique is then drawn down below and behind Poupart's ligament and the lower flap and stitched down to the pectineus muscle and Gimbernat's ligament to form a shutter closing the canal, while the lower flap is then sutured into the side of the upper flap in order to carry the strain, which is put upon the aponeurosis, directly down to Poupart's ligament. These supraligamentous operations are considerably more difficult to perform than the more old-fashioned ones; they should not be undertaken by an inexperienced surgeon, nor is it wise to use them in strangulated cases because of the difficulty in pulling up the sac and strangulated bowel from beneath Poupart's ligament.

The after-treatment of these operations is the same as that described for inguinal hernia on p. 591.

Strangulated Femoral Hernia. This is the commonest form of external strangulated hernia, and it may resemble closely inflammation of the inner inguinal lymphatic glands or of a saphenous varix. The strangulation is usually particularly tight owing to the sharp, hard edge of Gimbernat's ligament, and gangrene may occur rapidly, especially in elderly patients. Richter's hernia is not uncommon in this situation, and as it may take the form of a very small hernia and occur in fat people, it may be overlooked.

In operating upon a strangulated femoral hernia the constriction is best divided by turning the knife directly inwards and making two or three little nicks in Gimbernat's ligament. In a small percentage of cases in doing this an abnormal obturator artery will be encountered and cut, as is shown by the occurrence of free hæmorrhage. If this occurs the rupture is reduced, the wound must be enlarged, and the two ends of the vessel sought for and ligatured; this may necessitate incising the external oblique outwards for some distance.

Should the bowel be gangrenous, and resection and anastomosis be required, it will not be possible to do this through the ordinary hernial incision, and as the incision cannot be enlarged upwards without cutting Poupart's ligament, it is better to make a fresh incision above, opening the abdomen.

The gangrenous bowel should be excised through the hernial incision, the mesentery tied, and the bowel ends closed. The closed ends are then drawn up into the abdomen and the anastomosis easily performed through the abdominal incision.

UMBILICAL HERNIA

There are three quite distinct forms of umbilical hernia :—

(1) **Congenital Umbilical Hernia** (hernia of the umbilical cord). This is a rare condition, and is due to the lateral halves of the abdominal wall failing to close completely, so that a portion of the intestine projects into the cord itself, where it lies in a sac, surrounded by the thin, expanded structures of the cord, which itself appears swollen and enlarged and has an expansile impulse. If unnoticed during the confinement, the bowel may be ligatured when the cord is tied off, with the result that strangulation, followed usually by death, and occasionally by a fæcal fistula, will ensue. If untreated, and if this accident is avoided, this variety of hernia, nevertheless, usually will terminate fatally, for when the cord separates the peritoneum will become opened and septic peritonitis probably will result. The condition, therefore, always should be operated on at once if possible, the bowel being returned, the sac cut away, and the opening sutured.

Occasionally an extreme form of the condition is seen, in which the whole or greater part of the anterior abdominal wall is open (*exomphalos*). These children, if born alive, live only for a few hours, and nothing can as a rule be done for them.

(2) **Infantile Umbilical Hernia.** This is a common condition, which appears some weeks or months after birth, and is due to the umbilical scar

being weak and yielding as a result of abdominal pressure. Such conditions, therefore, as phimosis, chronic constipation, flatulence, enteritis and rickets will predispose towards the hernia. A definite sac of very varying size is formed, while in this type of hernia also certain enthusiasts claim that the sac is always preformed. The hernia gives rise to a small rounded projection, covered by what appears to be rather thin skin, sometimes of a bluish colour; it is always reducible, and usually disappears before adult life. This type of hernia passes absolutely through the umbilicus, and not to one side of it.

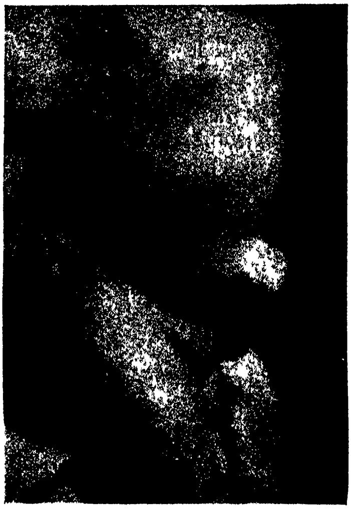


FIG. 216. Large infantile umbilical hernia in a child of twenty months.

The treatment is simple, and consists in keeping the hernia reduced by means of a broad strip of plaster applied across the abdomen; this may be reinforced by a coin or a disc of cork. The causes of rise of intra-abdominal pressure enumerated above, if present, also should be treated. By this means a cure almost always will be obtained, except in older children over the age of three or in the case of very large herniæ. Very few cases require operation, but should it be necessary from any of the above causes, an operation on the lines described on p. 604 should be performed, the sac being excised and the abdominal wall sutured together in a transverse direction.

(3) **Adult Umbilical Hernia.** This is a common condition and consists of a hernial protrusion containing either omentum or intestine, especially the colon, or both, which passes out as a rule through the linea alba, immediately above or below the umbilical scar. A peritoneal sac is present, but this is usually thin and adherent to the surrounding parts, while the sac tends to be loculated and may have more than one opening into it. The omentum usually lies in front and may surround the contained bowel. It is difficult to believe that this sac can be regarded as a congenital preformed condition, and as the condition is almost confined to fat people, it is probable that the intraperitoneal fat causes an increase of abdominal pressure while that in the abdominal walls stretches the abdominal tissues so that the protrusion can occur. The opening in the linea alba is usually small and round, with firm, hard edges and surrounded by scar tissue, while the shape of the hernia is that of a mushroom with a narrow neck. The recti muscles are widely separated, weak and flabby, while the coverings of the sac are formed by the expanded tissues of the linea alba.

Clinical Features. The condition is far more common in women than in men and is seen usually in those who are over thirty-five, who are very fat, who have borne children, and especially if they have a chronic bronchitic cough. The hernia develops slowly, and forms a round, painless, knobbly, lobulated swelling. The stretched umbilical scar usually can be seen over it, and the skin is often thin and red. The hernia is usually irreducible, and may become pendulous and hang down, while a well-marked expansile impulse is present. If the hernia is large, it appears to sit on top of the fat abdomen, which somewhat resembles the shape of a cottage loaf, while when the patient coughs the hernia is jerked upwards and becomes more prominent. Constipation and a sensation of weight and tenderness are often present. Obstruction in the hernia is by no means uncommon (see p. 569); strangulation also is a common complication, and should this occur it must be remembered that inasmuch as the sac is loculated and full of adhesions, it may be difficult to discover exactly in which portion of the sac the strangulation has occurred. Strangulation of an umbilical hernia often comes on insidiously.

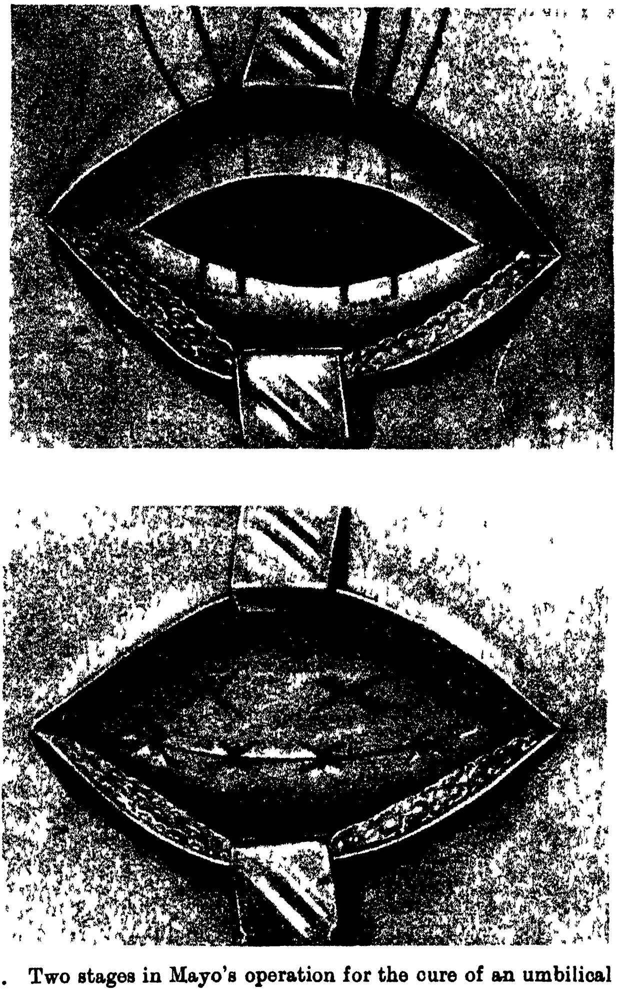


FIG. 217. Two stages in Mayo's operation for the cure of an umbilical hernia

The skin of the tumour always becomes stretched, thinned, and frequently involved in eczema and ulceration. In some cases the skin has given way and the hernia has burst, so that the bowel has gushed forth externally.

Treatment. Inasmuch as these herniæ are nearly always very large and irreducible, a retentive apparatus is little likely to be of value. Very small, early, reducible cases sometimes will be controlled by a properly fitting elastic abdominal belt with a pad over the aperture, while attention must be paid to the diet, the bowels, and any other cause of rise of intra-abdominal pressure.

In certain large and irreducible cases, where from the state of the hernia, or general condition of the patient, operation is impossible, a loosely-fitting belt will support the hernia and make the patient more comfortable, but there is no doubt that in the majority of cases operation will be found to be the best treatment and to give satisfactory results. A considerable number of recurrences are seen.

Operative Treatment. Inasmuch as the condition occurs nearly always in fat women, sometimes very stout, usually of middle age or over, and frequently with a chronic cough, they cannot be regarded as favourable subjects for operation. But in spite of this an operation performed properly gives good results, and these stout bodies usually do remarkably well. It is, however, essential that certain general principles of the operation should be observed. In all but very small cases it is quite useless to close the aperture through which the hernia protrudes by bringing it together from side to side, whether the edges are overlapped or not, as the continual pull of the oblique muscles during the movements of breathing or coughing certainly will cause the hernia to reform. Moreover the recti muscles are usually widely divaricated, and this alone renders it difficult, if not impossible, to bring them together from side to side. The muscles of the abdominal wall are also feeble, and the margins of the aperture through which the hernia protrudes fibrous, tough and hard. Whatever operation is performed, it is essential that the edges of the opening be overlapped for a considerable degree in order that broad surfaces may be brought into apposition with each other, and this overlapping should always be done from above downwards, so that the aperture is closed in a transverse direction and not from side to side as already stated above.

The standard operation, therefore, to be performed upon an adult umbilical hernia is one which is associated with the name of Mayo, and it is performed as follows : An elliptical transverse incision is made encircling the umbilicus. In very fat cases this will be a very large incision, and usually will embrace an area of skin at least a foot in length and 2 or 3 inches wide at its widest point. The fat is rapidly cut through until the linea alba and external oblique aponeurosis are seen, and the fat is then stripped up off the linea alba in all directions towards the hernial aperture until the firm, white, mushroom-like neck of the sac is seen. No other portion of the sac except its neck need be exposed. The sac has then to be opened carefully at its neck ; this is best done at the upper margin of the neck, as there is less likelihood of the contents being adherent at this point and getting damaged. A finger is introduced, the contents examined, and the neck of the sac then cut round, completely separating it from the linea alba all round. It will then be found that the sac, its contents, and the skin and fat over it are hanging loose, and only attached to the body by the contents passing through into the abdomen. The sac is then opened wider, and its contents carefully examined and set free. All bowel must be set free carefully and reduced within the abdomen, but any omentum may be left adherent to the sac, being tied and cut across at the point where it emerges from the abdominal cavity ; its stump is then reduced. Small intestine in the sac is usually free, colon is usually adherent, while the omentum is changed into a thick, tough mass of fibrofatty tissue adherent to everything with which it comes into contact. All omentum in the sac, therefore, however large its quantity, should be removed. The sac, with the skin and fat over it and adherent omentum inside it, is then free and can be taken away. Any adhesions of the omentum or bowel to the hernial aperture must then be set free. The round opening at the neck of the sac is now to be closed in a transverse direction by overlapping it. In order to do this two small incisions should be made directly outwards through the linea alba on either side of it for one inch or so, until the edges of the rectus muscle appear. Three or four strong silk mattress sutures are then introduced in the manner shown in the diagram, so as to draw the lower edge of the opening up behind the upper edge for ½ inch or so and to fix it there. When this is done the free edge of the upper flap, which is left protruding forwards, is sewn down to that part of the lower flap which lies immediately beneath it by three or four sutures to reinforce the overlap. The skin and subcutaneous fat are then closed as completely as possible, while it is wise to introduce a drainage tube into the subcutaneous tissues for forty-eight hours, as there is considerable tendency for an evil-smelling abscess to form in the loose fat otherwise.

This operation is eminently satisfactory, and there are very few cases of umbilical hernia which are too large or too fat or too bronchitic for it to be performed satisfactorily. After the operation the wound must be supported by strapping for two weeks or so, while after that a firm binder is of value. The patient should be warned carefully to avoid constipation and pregnancy.

Strangulated Umbilical Hernia. This is by no means uncommon and occurs in the same type of fat women as does the uncomplicated type of umbilical hernia. It often supersedes upon incarceration or obstruction of the hernia, and therefore appears to come on somewhat insidiously, though in the end strangulation may be severe and gangrene supervene. The operation is carried out as described above, and is followed by a radical cure. In most cases it will be found that the strangulation has occurred at some point within the sac, as the result of bands or adhesions, and not at the neck of the sac.

VENTRAL HERNIA

Any protrusion of abdominal contents which occurs through the anterior abdominal wall at some spot other than the inguinal, femoral, or umbilical regions is known as a ventral hernia. There are several varieties.

(A) **Post-operative or Incisional Hernia.** Any operation wound in which the abdomen has been opened may become the seat of a hernia some weeks, months or years afterwards, but with modern incisions, carefully planned, adequately sutured, and kept free from infection, the condition is rare. It occurs in about one per cent. of upper and three per cent. of lower abdominal scars. If, however, the wound suppurates or has been left partly open for the insertion of a drainage tube, or has been imperfectly sutured, the condition is by no means uncommon. Old age, deficient muscular power, an incision which divides muscular tissue or the nerves of the abdominal wall, and the presence of marked straining or coughing after the operation all increase the liability to the condition. It usually occurs within a few weeks of the operation. Fifty per cent. of these herniæ occur within six months of the operation. Incisions in the midline through the linea alba are the most prone to develop this condition, while those in which the rectus muscle is temporarily drawn aside, or in which the abdominal muscles are split in the direction of their fibres, are the least prone to it. The condition is particularly common after operations for appendix abscess. Such a hernia may vary from a small bulge to an enormous, lobulated, pedunculated swelling in which the bowel has no covering except the skin, through which its coils can clearly be seen moving about; in this latter case the skin is liable to rupture and the bowel to emerge (*ruptured ventral hernia*). The swelling has all the physical signs of a hernia (see p. 567), and is usually accompanied by a sense of weakness and incapacity, sometimes by gastro-intestinal disturbance. The hernia is usually reducible, while sharp edges of scar tissue may be felt at the upper limit of the bulge and the neck is often quite small and very hard. In many instances the hand can invaginate the skin and pass right inside the abdomen. Strangulation in these herniæ is not common.

Treatment. If possible, operation should be performed; this usually can be done unless the gap is very wide, the hernia very large, or the patient generally unfit.

The operation consists in removing a small elliptical area of skin and carefully opening the abdomen again at the site of the bulge; care must be taken, as the abdominal contents will very likely be adherent to the anterior wall at some spot. The various layers of the abdominal wall are then identified by dissecting away the scar tissue, and set free from each other for ½ inch or so. They are then sewn up in order in the usual way, if possible with a certain amount of overlapping. A few cases will be seen in which this cannot be done owing to the large size of the aperture or to the rigidity and unyielding character of the anterior abdominal wall in its neighbourhood. In this case the gap may be closed by the insertion of a silver-wire filigree, which is implanted in the extraperitoneal tissues, or better by suturing in a wide graft cut from the fascia lata and inserted within the muscular wall of the abdomen. Sutures made of strips of fascia may be used with advantage.

In any variety of hernia a cure often can be obtained by the method of suturing in a graft of fascia lata to fill up the gap. This method has been recommended strongly by Gallie.

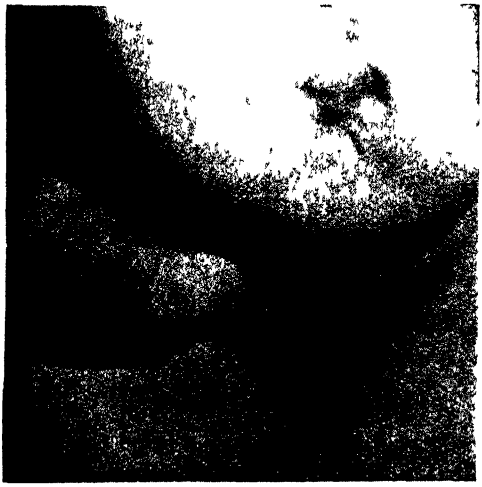


FIG. 218. Pedunculated ventral hernia through a McBurney muscle-splitting appendix incision.

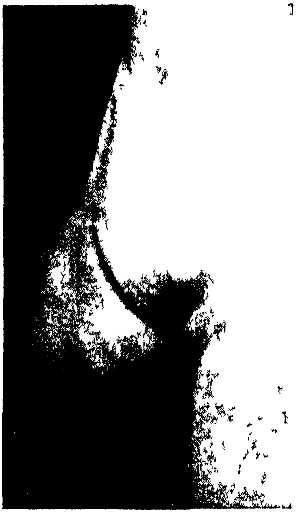


FIG. 219. Ventral hernia through an operation scar. The sac contained numerous hydatid cysts.

If for any reason operation is contra-indicated, an abdominal support or apparatus of some kind must be worn.

(B) **Epigastric Hernia (Fatty Hernia of the Linea Alba).** Small openings are occasionally found in the linea alba, semilunar lines, or transverse intersections of the rectus, almost always above the umbilicus. The openings are probably congenital, and are due to the fact that the linea alba is formed of interlacing fibrous fibres, which in some cases form a comparatively open network, so that one or more open spaces about ¼ to ½ inch in length may be left, which may subsequently increase in size. When this occurs some of the loose extraperitoneal fat may become protruded through the opening and appear as a small, fatty localised tumour under the skin (*epigastric lipoma, properitoneal lipoma*). After some time this fatty mass will increase in size, and as it protrudes further forward will drag with it a small peritoneal sac, which will be found at its centre; thus it ultimately becomes a hernia.

The condition is seen usually in males who do heavy work and are approaching middle age, where it appears as a small flattened, soft, round tumour, with all the characteristics of a lipoma, and usually with an impulse on coughing. Though in many cases they cause no symptoms whatever, they are not infrequently accompanied by severe abdominal symptoms, indigestion and severe epigastric pain and vomiting, this probably being due to traction upon the peritoneum. It should be remembered, however, that such abdominal symptoms may quite likely be due to disease within the abdomen, and the epigastric hernia be an independent condition. Strangulation of such a hernia is rare, but we have seen one case where a loop of bowel was tightly strangulated in a hernia of this kind, 1 inch below and 2 inches to the left of the umbilicus.

Treatment. The treatment consists in operation directed at removing the sac and the lipoma, while the opening is closed in the same way as described for umbilical hernia (see p. 604). In those cases which are causing pain and vomiting most remarkable relief is experienced.

(C) **Divarication of the Recti.** This consists in a separation of the recti abdominis muscles due to stretching and broadening of the linea alba ; it is not strictly a hernia at all, as no sac is present. It is seen in two distinct types : (*a*) One variety occurs above the umbilicus in young children, where, when the child strains or uses his rectus muscles, a soft, elongated protrusion appears above the umbilicus. This variety is symptomless and requires no treatment, as it will disappear as the child grows bigger. It is not infrequently associated with rickets.

(*b*) A somewhat similar condition occurs in women who have borne children, in whom it is seen below the umbilicus ; or sometimes the linea alba is so stretched that the recti are separated for almost their whole length. On using the recti, as by raising the head and shoulders from the bed, a cylindrical soft protrusion occurs between the muscles, while the fingers easily can be introduced into the abdomen between the edges of the two muscles. Most cases are symptomless, but in other instances the lack of support given to the abdominal contents gives rise to pain, indigestion and discomfort.

Treatment. In most cases a belt should be worn, and if this is efficient and properly fitted it will cure the condition and keep the patient comfortable. In a few cases the symptoms are so severe that, if they are not relieved by a belt, operation may be desirable. A longitudinal incision is made through the linea alba, which is dissected free from the skin and peritoneum; the two sides are drawn together so that one overlaps the other and are sutured there.

(D) **Hernia through the Linear Semilunaris.** This bulges out—through the lower part of the linea semilunaris and through the conjoined tendon, and is what is known as an internal direct inguinal hernia. It is described on p. 584.

LUMBAR HERNIA

This is the name given to a protrusion which occurs between the last rib and the crest of the ilium. It is a rare condition, which occurs in two forms :—

(*a*) The least uncommon variety is that which may follow incisions in this neighbourhood where the scar has given way as the result of drainage, suppuration, etc. This may be the result of operations upon the kidney or for drainage of a lumbar abscess, etc.

(*b*) More rarely it occurs as a spontaneous condition in which the hernia bulges out at the side of the erector spinæ between the latissimus dorsi and the external oblique muscle; the space is bounded below by the iliac crest, and is known as the triangle of Petit.

This condition is most common on the left side in men, where it gives rise to a round, soft, spherical swelling, usually reducible and with the characteristic features of a hernia. It may resemble closely a lumbar abscess, especially a loculated or hour-glass-shaped abscess, with a small opening connecting its two divisions. Strangulation of such a hernia has been described. The condition does not as a rule cause any symptoms, and should either be supported by a belt or cured by a radical operation on the lines of that described for ventral hernia.

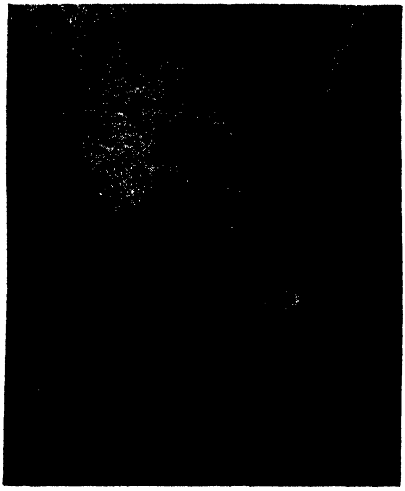


FIG. 220. Lumbar hernia.

OBTURATOR HERNIA

This is a hernia which protrudes through the upper part of the obturator or thyroid foramen. It passes along the opening for the obturator artery and nerve and emerges into the upper and inner part of the thigh, passing either between the obturator membrane and the obturator externus muscle or between that muscle and the pectineus. The obturator vessels and nerves may be found on either side of the sac. It seems possible that this condition may be due to a congenital sac formed in the course of the development of the obturator artery.

The condition is most commonly seen in middle-aged women who were stout, but have recently become thin. It cannot be recognised, however, unless strangulation has occurred, and even then it is only diagnosed, as a rule, when the abdomen has been opened for an obstruction of uncertain origin. It almost invariably contains a strangulated loop of small bowel, the hernia being of Richter's type. The symptoms are those of internal strangulation in general (see p. 678), while, in addition, the patient complains of pain passing down the inner side of the thigh to the knee; this may be accompanied by numbness down the course of the obturator nerve. In some cases there will be a fulness, and more often tenderness or resistance, immediately below the inner end of Poupart's ligament, in the neighbourhood of the origin of the adductor muscles, while movements of the limb on the affected side may be painful. Rectal or vaginal examination sometimes will show tenderness, or even swelling, on the inner side of the obturator membrane.

Treatment. This consists in the treatment of the condition when it is strangulated, as it will not be recognised otherwise. If diagnosed before operation, a vertical incision is made over the inner end of Scarpa's triangle, the pectineus muscle is split, the sac found and opened, the strangulation relieved by nicking the membrane inwards and downwards, and the hernia reduced. An attempt must then be made to close the neck of the sac by a purse-string suture. More commonly, however, the condition is discovered after the abdomen has been opened for obstruction ; the bowel must then be most gently withdrawn from the sac from inside the abdomen, while a second incision over and down to the hernia will be of assistance.

There are certain other rare forms of hernia, such as the *perineal*, *gluteal*, and *sciatic* varieties, which are so rare as to merit no description.

Diaphragmatic Hernia. This is described on p. 462.

Hernia en Glissade. This has been described shortly on p. 563, in connection with hernia in general. It is seen most commonly in inguinal herniæ, but is occasionally found to occur in the femoral variety, while the viscera which enter into it are almost invariably the cæcum and appendix on the right side, the pelvic colon on the left side or the bladder on either side. In this type of hernia the portions of bowel descend into the femoral or inguinal canal and lie behind or outside the peritoneum, which only covers their anterior surfaces, the posterior wall of the viscus being in contact with the tissues forming the canal in which it lies. The condition cannot be diagnosed for certain, but the hernia is usually big and irreducible, and occurs in middle-aged people. Strangulation is rare, and it is said that in such an inguinal hernia it is sometimes possible to bring the contents down again after they have been reduced by dragging upon the testicle.

Treatment. As a truss almost invariably fails to control such a hernia, operation will be necessary, and it may be a difficult proceeding, for if the condition is not recognised in time the bowel or bladder may well be mistaken for the sac and opened. When the condition is recognised, the peritoneum on the front wall of the bowel is incised, the piece of bowel behind set free and pushed through the opening made in the peritoneum, while the edges of this opening are then sewn together round the bowel so as to keep it within the peritoneum. The cure of the hernia is then done in the ordinary way, Gallie's operation and filigrees being of special value in this type of operation.

CHAPTER XV

THE STOMACH AND DUODENUM

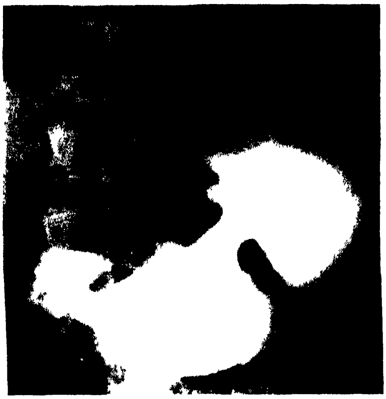
Surgical Anatomy. *The stomach* consists of two main portions, the left-hand saccular portion or fundus, which reaches up towards the fifth left rib in the mammary line, and the right-hand portion or pyloric part, which lies chiefly to the left of the middle line, but which, as it passes to the right and becomes converted into the pyloric antrum, comes to lie over the spine or even to the right of it. The cardiac orifice, or œsophageal opening, is found ½ inch to the left of the sternal edge and at the level of the seventh costosternal junction, while the pylorus lies in Addison's transpyloric plane, which is midway between the pubic symphysis and the suprasternal notch. The fuller the stomach is the lower will be the pylorus, and the more it will tend to pass to the right. A marked thickening of the circular muscle is found at the junction of the pylorus and duodenum, this forming the pyloric sphincter. The thickening is most marked on the upper surface of the pylorus, where it must not be mistaken for a small ulcer. A large vein usually can be seen running downwards across the front of the pylorus, which is usually situated about ½ inch to the left of the actual junction between the pylorus and duodenum. This is known as the pyloric vein of Mayo.

The position and shape of the stomach will depend entirely upon whether it is empty, full or pathologically dilated.

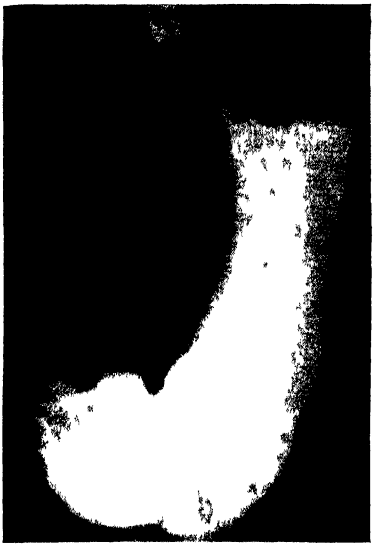
When empty and flaccid the organ is flattened and the greater part of it except the pylorus is concealed behind the ribs and liver, but in conditions where gradual starvation is present, such as is caused by carcinoma of the œsophagus, it will be found to be even higher up and contracted into a more or less cylindrical tube. As the stomach fills the greater curvature descends until, when moderately full, it may be about the level of the umbilicus, though it must be remembered that the muscular tone of its walls, the position of the patient and the state of the abdominal muscles will exert considerable influence upon its position. Should it become pathologically dilated, the greater curvature may descend considerably further, even to the level of the pubes or the left iliac fossa. The pylorus and lesser curvature are, however, more or less fixed in position by the lesser omentum and coronary vessels, while the left side of the stomach is supported by the gastrophrenic ligament; these portions of the stomach, therefore, do not move down much, however greatly the organ is distended, unless a generalised visceroptosis is present, while the cardiac orifice never changes its position. The pylorus and first part of the duodenum usually point backwards and to the right, though if the stomach be very full they will tend to point to the left, while the circular muscle of the pyloric sphincter bulges into the duodenum in a fashion rather resembling the external os of the uterus. A normal pylorus should permit the index finger to invaginate the stomach wall and pass through it. On examining the pylorus during operation, little pale raised knobs and ridges often will be seen upon it, which are due to small areas of local spasm in the muscle; these must not be mistaken for pathological conditions. It must be remembered also that considerable displacement of the stomach will occur as a result of distension of the colon or enlargement of the neighbouring organs, such as the spleen or liver.

Various special methods of examining the stomach are employed. If the stomach is dilated and the pylorus obstructed gastric peristalsis will be visible in the form of waves passing from left to right across the upper half of the abdomen, while they may be stimulated by flicking or tapping the organ through the abdominal wall. Its size and amount of dilatation can also be ascertained by such old-fashioned tests as auscultatory percussion, shaking the patient to obtain a succussion splash or inflation with effervescing powders or by means of a stomach tube and air pump. All these methods have, however, now given place to the much more valuable examination which can be made by means of radiography, a full description of which will be found in Ch. XXIII., Vol. I. By this means the outline, shape of the stomach, motor activity, time of emptying and amount of dilatation, can be ascertianed at once. The normal stomach should have emptied itself completely in from two to four hours.

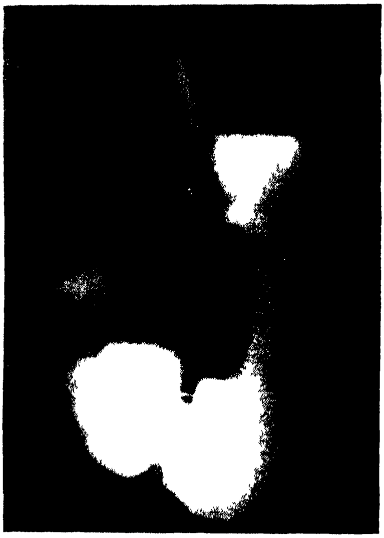
PLATE IV.



Barium meal showing the crater of an ulcer on the lesser curvature of the stomach with spasm



Barium meal showing deformity of the duodenal cap due to a duodenal ulcer



Barium meal showing irregular filling defect due to carcinoma of stomach

The digestive and other functions of the stomach have been examined also by the use of a test meal, by means of which the total acidity, the free hydrochloric acid and the presence of other chemical bodies are ascertained. We are, however, of the opinion that the indications obtained by a test meal are both unreliable and uncertain, and in no way comparable to those obtained by means of X-ray pictures. Examination of the fæces sometimes will shed light upon gastric and duodenal conditions.

A normal, healthy stomach is practically free of bacteria. It may be regarded as sterile when empty, but for a short time after a meal bacteria introduced with the food will be detectable; these, however, soon disappear as digestion proceeds. Should stasis be present in the stomach, however, as the result of pyloric obstruction, spasmodic or organic, the gastric contents will be far from sterile, and virulent and pathogenic organisms will be present in large quantities.

Gastroscopy. The inside of the stomach can be inspected directly by means of an instrument known as a gastroscope, which is devised on the same lines as the cystoscope, the flexible instrument being more used than the rigid one in this country.

The patient, who is under the influence of morphia, has the mouth, pharynx and hypopharynx thoroughly anæsthetised with 2 per cent. novocain. The instrument is then passed back and down the œsophagus to the stomach, which is distended with air after having been emptied by a stomach tube. By this means a fairly clear view can be obtained of the lesser curvature and the pyloric antrum. Ulcers and carcinomata can be detected, and their progress noted on subsequent examinations, while through the operating gastroscope portions of the edges of doubtful ulcers can be removed for biopsy.

An ingenious device by which a small camera may be introduced into the end of the instrument, for the purpose of obtaining a photograph of the interior of the stomach, has also been invented.

The use of these instruments should be limited to those cases in which X-ray films and test meals have failed to reveal any definite lesion, or to cases where the establishment as to whether a lesion is malignant or not is in doubt, for the use of the instrument puts the patient to considerable discomfort, and is not entirely without danger—even in the hands of an expert, by whom alone it should be passed.

The Duodenum. This is for the greater part of its length a fixed and retroperitoneal organ, the greater part of the first portion being entirely surrounded by peritoneum, the second portion having a peritoneal covering only on its front and right side, and the third portion being covered only in front and below. Close to the duodenojejunal flexure, three retroperitoneal fossæ are occasionally found in which herniæ may occur, as will be described later. It is by no means unusual, however, to find an abnormally mobile duodenum. This is commonest in the female, and it may be associated with a considerable degree of dilatation. In some instances the duodenum can be lifted to the anterior abdominal wall. The place at which the second or descending and the third or ascending portions of the duodenum meet is sometimes known as the inferior duodenal flexure. Foreign bodies are occasionally seen to be impacted there, especially if they are long and thin.

The junction of the foregut and midgut during the developmental process occurs at about the centre of the duodenum, and it is at this site that certain rare congenital abnormalities are occasionally seen. The third or ascending portion of the duodenum is crossed about its centre by the root of the mesentery and the superior mesenteric artery. It is thought that in certain cases this artery produces a constriction of the duodenum leading to dilatation of the bowel, which will be described later. At the end of the third portion of the duodenum the bowel bends sharply forwards and downwards from the left side of the body of the second lumbar vertebra, and here the jejunum commences, the junction being known as the duodenojejunal flexure. This is one of the most fixed points of the whole bowel, the junction being fixed to the crus of the diaphragm by means of the suspensory ligament of Treitz, which can be seen easily and resembles a thin fold of peritoneum at this spot.

On the left side and posterior aspect of the middle of the descending portion of the duodenum the common bile-duct and the pancreatic duct pass through the wall of the duodenum and open into the bowel usually by a common opening placed at the top of a small elevation known as the papilla of Vater. Occasionally an accessory pancreatic duct (duct of Santorini) is present, and this opens a short distance in front of the foregoing.

In common with the other abdominal viscera, attempts have been made to inspect the outside of the stomach and duodenum by means of the cystoscope introduced into the peritoneal cavity through a puncture in the abdominal wall. The peritoneum is first distended with air or oxygen.

The duodenal tube is used by certain authorities as a means of obtaining a fractional test meal from the duodenal contents and to obtain pure bile from the gall-bladder. It is difficult to pass and very uncomfortable for the patient.

INJURIES OF AND FOREIGN BODIES IN THE STOMACH

Injuries to the stomach may be of three kinds. They are none of them common, owing to the way in which the organ is protected by the ribs :—

(*a*) Contusions.
(*b*) Ruptures.
(*c*) Penetrating wounds.

(*a*) **Contusions.** Contusions of the stomach are produced by moderately severe blows in the epigastrium. The condition is accompanied by some degree of shock and collapse, while there may be a small amount of vomiting of blood. Rigidity, marked rise of pulse rate, severe pain, and persistent vomiting are absent, and the patient will soon recover. In some cases this condition is followed by a traumatic effusion into the lesser peritoneal sac. No treatment beyond rest in bed is required.

(*b*) **Rupture of the Stomach.** This is usually due to severe blows in the epigastrium, and is especially liable to occur when the stomach is distended with food, the anterior surface in the pyloric half usually being torn, so that the contents escape into the general peritoneal cavity. If, however, the posterior portion of the stomach is damaged, the leak will be into the lesser sac. There may or may not be obvious damage to the abdominal wall. It must be remembered that in this and the next condition it is highly probable that other viscera besides the stomach will be injured, especially the liver or spleen. The symptoms and treatment of this condition will be considered under the next heading, as they are practically identical in the two conditions.

(*c*) **Penetrating Wounds of the Stomach.** Wounds of the stomach are usually produced either by a bullet, shell fragment, bayonet or knife ; sometimes they are produced from within by sharp foreign bodies which have been swallowed ; naturally they are rare in civil life. A few have been seen as the result of passing œsophageal bougies or in the case of professional sword swallowers. It may be assumed that in all cases of wounds of the stomach gastric contents will escape into the peritoneum and hæmorrhage will occur from the stomach vessels. Thus, after some hours, peritonitis will follow in untreated cases. It should be remembered also that the wound of entrance in the abdominal wall will not necessarily lie over the stomach itself, and in many cases of gunshot wound involving the thorax the stomach is injured. For a further discussion of abdominal wounds, see p. 515.

Clinical Features. The clinical features of a rupture or wound of the stomach consist primarily in marked shock and collapse, which persist for some time, the patient being pale, the temperature subnormal, the pulse thin and running. Collapse is less marked when the stomach is empty than when it is full, while in cases where the stomach is empty there may be very few symptoms indeed for some hours. The other symptoms are those of injury to a hollow abdominal viscus in general, and are described on p. 521. They may be summed up as consisting of increasing abdominal pain, abdominal rigidity—both of which are most marked in the epigastrium—and increasing vomiting, while the signs of general peritonitis rapidly and surely set in, soon leading to death. The special symptoms which call attention to the wound being in the stomach are that the vomit probably will contain blood, fresh or old, while in the case of gunshot wounds sometimes the projectile fragment is also vomited. This latter sign, which might well be regarded as infallible, is not so always, for we operated upon a soldier in a clearing station with a wound in the epigastrium who, in addition to all the other signs of a wound in the stomach, had vomited blood and a small piece of shell, confidently expecting to find a wound in the stomach; there was, however, no lesion of the digestive canal at all, and the patient rapidly recovered; presumably he must have had the piece of shell in his mouth and swallowed it afterwards.

In a few instances, where the gastric perforation is very small and the stomach empty, the extravasation has been small enough to become localised by adhesions, so that general peritonitis has not occurred, but merely a localised perigastric abscess (see p. 624). In rare cases, where the posterior wall of the stomach alone is injured, the symptoms will be very masked; effusion, and later abscess formation, will occur in the lesser sac only, as in the case of a perforated gastric ulcer in this situation.

Treatment. It may be assumed that the patient has no chance of recovery unless early operation is undertaken. No time, therefore, should be lost in performing a laparotomy if there is a reasonable suspicion that a hollow viscus is injured. If a wound in the stomach is present, it usually can be sutured easily with a double row of continuous sutures; the abdomen should be sponged dry, and if the wound has been present less than twelve hours there need be no drainage. The after-treatment and complications are the same as those in the case of a perforated gastric ulcer (see p. 622). The following points should be carefully noted:—

(*a*) The posterior wall of the stomach must be examined carefully as well as the anterior.

(*b*) The probability of wounds in other viscera, such as the spleen, liver, intestine, diaphragm and lungs, must be borne in mind.

(*c*) On no account should irrigation of the abdomen be performed (see p. 624).

(*d*) In late cases, where general peritonitis is present, the proper treatment for that condition should be administered (see p. 538).

The special treatment of abdominal wounds necessitated by the conditions of active warfare is discussed in works on Military Surgery and in the Appendix to Vol. I.

Foreign Bodies in the Stomach. Hair Balls. Foreign bodies in the stomach are by no means uncommon. In children coins, buttons, pins, tin whistles, and other small toys are frequently swallowed; in adults, tooth plates, fish bones, and pins will be found; while in lunatics any variety of article is sometimes present in very large numbers: forks, spoons, knives, and pieces of glass have been found.

In girls who bite or chew their hair, especially neurotic patients, and in lunatics the formation of a *hair ball* in the stomach sometimes occurs; the condition is also common in cows, Persian cats, and goats. The swallowed hair becomes rolled up in the stomach into a ball or mass, which in the course of years becomes solid, firm, may weigh as much as 3 lb., and occasionally forms a complete cast of the stomach, with projections entering the duodenum and œsophagus.

It should be remembered in general that most bodies which pass down the œsophagus will probably pass out through the pylorus, and if they pass through the pylorus they are not likely to get impacted until they come into the neighbourhood of the ileocæcal valve. Foreign bodies impacted in the duodenum are therefore very rare (see p. 635). The rounder and smoother a body is the more likely it is to pass out satisfactorily, while large bodies, or jagged and irregular ones, probably will be retained in the stomach. In some instances a large number of heavy metallic bodies in the stomach have dragged the organ down so that it has come to lie in the pelvis. If a foreign body remains in the stomach for some time, it will cause irritation and ulceration of the mucous membrane, while a few instances have been recorded where sharp bodies have perforated the stomach wall and caused either general peritonitis, localised perigastric abscess, or even some form of gastric fistula.

Clinical Features. During the process of swallowing the foreign body hawking, choking, pain and discomfort will occur (see p. 356). After this most bodies lying latent in the stomach give rise to no symptoms whatever. In other instances there will be epigastric pain and vomiting, which may be bloodstained, this being the result of gastric irritation. Examination reveals no physical signs except, possibly, slight rigidity. If the body is large, as in the case of a hair ball, a solid tumour may be felt in the epigastrium; in the case of the latter condition, when it has been present for many years, there will be emaciation, vomiting, and a round, movable, palpable tumour, which is frequently diagnosed as a simple growth of the stomach or a movable kidney.

X-ray examination is most important. If the body is opaque to X-rays it will be revealed at once, while in the case of a hair ball an X-ray film taken with a bismuth or barium meal will reveal a characteristic smooth filling defect (see Vol. I., Ch. XXIII.).

Treatment. In the case of large foreign bodies, hair balls, or foreign bodies which have been in the stomach for more than two or three weeks, removal by operation is the only course. A laparotomy is performed, the anterior wall of the stomach incised, the body removed, and the stomach wall closed in two layers. In the case of smooth, round objects, however, it is surprising how well they will pass through the pylorus and emerge at the anus. A halfpenny or shilling, and any coin or marble smaller than this, probably will pass the pylorus in a child of over three; half-crowns and pennies probably will pass through an adult; ordinary pins nearly always will pass through, but safety pins and dentures probably will not do so. In all these cases, therefore, it is advisable to wait for a few days, examining the stools, while the position and course of the foreign body can be followed by frequent X-ray films. If the body has sharp edges or spikes, its passage will be assisted by giving the patient large, soft meals of porridge, peas, and other pultaceous food, while chopped up worsted or string may be added to the food in order that the fibres may become wrapped round the foreign body and protect any sharp points and jagged edges. On no account should an aperient be given. If a foreign body has been in the stomach more than a fortnight, it should be removed.

DISEASES OF THE STOMACH

Too great stress cannot be laid upon the importance of a complete history and careful examination of all the various systems of the patient. It should be remembered in particular that gastric lesions are often simulated by phthisis, gastric crises of tabes, and caries of the spine or spinal tumour.

Acute Phlegmonous Gastritis. This is a very rare condition, in which primarily the submucous coat of the stomach becomes involved in an acute infection due to a streptococcus, the whole stomach wall becoming infiltrated, thickened and œdematous. Suppuration usually occurs, and gives rise to a series of abscesses or a diffuse cellulitis of the stomach wall. In some instances complete sloughing of the mucous membrane occurs, while general peritonitis is likely to supervene. There is a sudden onset, usually in dyspeptic people, while the condition is probably due in some cases to alcoholism, and in others to swallowing corrosive substances. Puerperal fever, gastric ulcer, and recent operations upon the stomach have also been described as causes. There is severe epigastric pain, tenderness, rigidity, and vomiting, the temperature is high and the patient profoundly toxic, with restlessness, delirium, and rapid pulse. Local abscesses may form and burst into the stomach or peritoneum. Death usually follows from general exhaustion or peritonitis, while should the patient recover, stricture and deformity of the stomach will occur. The diagnosis is practically never made before operation ; a laparotomy is usually performed, and, when recognisable, abscesses may be drained ; otherwise the treatment is purely symptomatic. It is probable that sulphanilamides will prove of value in this condition.

A very similar condition follows the *swallowing of corrosive fluids*, acid or alkaline. The lesser curvature and pylorus are most affected, and the condition is often rapidly fatal from perforation of the stomach or extensive sloughing. After swallowing such a fluid there is intense pain, collapse, and vomiting of liquid, which contains mucus, shreds and blood. If death does not occur the condition will be followed by marked scarring and stricture of the stomach, hourglass deformity and pyloric stenosis occurring. Similar damage and sequelæ are certain to occur in the œsophagus. These contractures will certainly require surgical treatment later (see p. 625). In the acute stage a jejunostomy may prove satisfactory as a means of resting the stomach and feeding the patient.

GASTRIC ULCER

This is an exceedingly common condition, which leads to much ill-health and gives rise to many serious complications. Though in many cases the treatment of the condition is surgical, the diagnosis, and in some instances the treatment also, are often regarded as coming within the realm of medicine and are fully described in medical text-books ; in all cases close co-operation between the physician and the surgeon is advisable. We, therefore, shall content ourselves with only a very short discussion of the pathology, diagnosis, and medical treatment. The complications and their treatment may be regarded as entirely surgical.

Two forms of gastric ulcer are seen : (*a*) acute ; (*b*) chronic.

(*a*) **Acute Gastric Ulcer.** This is a common condition which usually occurs in anæmic young women, especially servants, who drink a lot of tea and have irregular meals. It may occur anywhere between the pylorus and the œsophagus, may be multiple, is small and circular in shape, with sharp-cut edges and without induration around it ; the ulcer is funnel-shaped, while perforation rarely occurs. Hæmorrhage is, however, common, but seldom fatal. These ulcers are most common near the pylorus ; they heal spontaneously and rapidly, they rarely produce contraction or deformity of the stomach, and their symptoms are similar to those of a chronic ulcer (see p. 616), but more severe and of more recent origin. The prognosis is good and the treatment entirely medical, except when perforation occurs. In the case of a hæmorrhage from such an ulcer, the surgeon should on no account be led into an operation in an attempt to stop it, as the bleeding points are difficult or impossible to find and no benefit usually follows.

(*b*) **Chronic Gastric Ulcer.** This is a more common condition, which is generally seen in middle-aged men, is usually solitary and of long duration. The cause of the condition is unknown, it being variously regarded as being due:—

(1) To sepsis and infection in the mouth, bowel or elsewhere. Oral sepsis is very frequently present.

(2) To the result of thrombosis or embolism of gastric arteries, this permitting the gastric juice and gastric movements to damage the mucous membrane.

(3) To the effects of anæmia, cardiac disease, arteriosclerosis, etc.

(4) To the result of a specific infection of unknown origin.

(5) The prolonged use of unsuitable foods, especially fats in excess, which take a long time to digest, and lead to damage of the gastric epithelium by the regurgitation of bile and pancreatic secretion, regurgitated through the tired pylorus into a stomach deprived of its normal protective acid secretion.

The chronic ulcer may be small or very large, is occasionally multiple, and has an irregular shape, with much induration and œdema around it. Scar tissue is formed round, and the peritoneum over it is white and thickened. The mucous membrane is affected at first, and later the muscles, peritoneum and structures in contact with the stomach. These last become adherent and involved in the ulcer. If such adhesions are formed the ulceration may extend into the pancreas, liver or abdominal wall; this is known as a *penetrating ulcer*. If an opening occurs through into the general peritoneal cavity, it is known as a *perforating ulcer*. Around the ulcer chronic inflammation occurs, and leads to profuse adhesions. Such chronic ulcers are usually single, and most commonly in the neighbourhood of the pylorus or lesser curvature; they are seen on either the back or the front of the stomach, while they may be very large and spread down both sides of the stomach; their edges are raised and hard. Hæmorrhage is by no means rare, and, as large vessels may become eroded, it is sometimes fatal. In some cases, as the result of scarring and inflammatory tissues round, quite a large tumour may be formed, which may prove difficult to distinguish from a malignant growth even when the abdomen is opened, while in the process of healing the excessive scar tissue tends to contract and produce deformity and stenosis of the stomach. It is thought by some authorities that a chronic ulcer may form the starting point of carcinoma; this is, however, by no means proved, and probably does not account at most for more than 20 per cent. of cases of gastric carcinoma.

Clinical Features. The chief symptom is pain, usually in the middle or left side of the epigastrium near the xiphoid, passing through to the back, and generally coming on within half an hour or an hour of taking food. It may be slight or very intense, and is sometimes referred to the back between the shoulders, while severe pain, especially if it goes through into the back, suggests that there is a deep penetrating ulcer involving the pancreas and that therefore it is not likely to respond to medical treatment. The nearer the ulcer is to the pylorus, the lower down is the pain and the longer its interval after a meal. The actual cause of the pain is not known for certain; it may be due to a subacute inflammatory change which settles down from time to time and thus gives rise to remission of symptoms. Diffuse tenderness and possibly a little rigidity of both upper recti are present; vomiting and acid eructations are common, and the former tends to relieve the pain. At times there is definite tenderness actually over the site of the ulcer; this is probably the result of a small inflamed patch of peritoneum at the ulcer base. Hæmorrhage into the stomach will lead to profuse vomiting of bright or dark blood (hæmatemesis), and tarry stools (melæna), but this is to be regarded as a complication rather than a symptom. Hyperæsthesia of the skin is an uncertain sign. The symptoms show a slight tendency to remissions, though these are much less striking and regular than in the case of a duodenal ulcer; many slight changes, such as alteration of diet, rest in bed, change to a warmer climate, alteration of daily habits, etc., will give relief for a short time. In some cases ulcers lie latent and symptomless for long periods. A test meal shows a high degree of free hydrochloric acid (hyperchloridia), though this is by no means constant. In old-standing cases anæmia and wasting are very marked.

X-ray examination is of the greatest value, as in most cases the crater of the ulcer can be seen, when filled with bismuth or barium, as a persistent mushroom-shaped excrescence standing out from the stomach shadow. It may require massage and manipulation of the stomach to produce this. Incidental and indirect X-ray evidence can also be obtained as to the time of emptying of the stomach, which may be increased or diminished, and the presence of persistent spasm, displacement or deformity (see Vol. I., Ch. XXIII.).

The diagnosis will have to be made from functional dyspepsia, appendix dyspepsia due to chronic appendicitis, gall-stones, and other chronic abdominal lesions. It should be remembered that hæmatemesis in a man points strongly to the presence of organic disease of some kind, but not necessarily gastric ulcer. In a woman, however, it is not necessarily associated with demonstrable disease of any kind.

Treatment of Uncomplicated Gastric Ulcer. The treatment of uncomplicated gastric ulcer can be considered in no way to be settled at present. There is no doubt that an acute ulcer almost always will heal under careful medical treatment, and in such a case no form of surgery is indicated. In the chronic forms of ulcer medical treatment always should be tried first. Into the details of the medical treatment of gastric ulcer a surgical textbook cannot go, and it will suffice to remark that it is both tedious and lengthy if properly carried out, as it entails rest in bed, a rigid diet, the continuous administration of large quantities of alkalis and careful attention to the teeth, habits, smoking, etc. It is by no means sufficient to put a patient upon light work, fish diet, and a bottle of bismuth and soda. With regard to the efficiency of medical treatment, a certain number of early cases are undoubtedly cured, but the more chronic the ulcer the less likely is medical treatment to succeed. Adequate medical treatment will relieve the symptoms temporarily in most cases, but on resuming normal life it is highly likely that the symptoms will recur. *Histidine* injections have lately been used to supplement medical treatment and have gained some measure of success; histidine is an amino-acid and is thought to produce a secretion of thick mucus in the floor of the ulcer which protects it from irritation of the gastric juices.

The indications for surgical treatment, therefore, may be summed up as the following:—

(*a*) Failure of adequate medical treatment, or recurrence of symptoms soon after treatment.

(*b*) Chronicity of the ulcer.

(*c*) The presence of a large crater or of involvement of the liver or pancreas.

as shown especially by the increase of pain, by constant radiating pain in the back, and the X-ray picture.

(*d*) The presence of dilatation of the stomach from pyloric stenosis or of hourglass contracture.

(*e*) A suggestion of the onset of carcinoma as shown by more continuous symptoms, marked loss of appetite and no relief on vomiting.

(*f*) Perforation.

(*g*) The occurrence of one or more severe hæmorrhages.

The treatment of nearly all the complications is surgical (see pp. 621–626).

The *surgical treatment* will consist in laparotomy, and it is impossible to foretell what operation will be necessary until the abdomen is opened and the ulcer unveiled. The general preparations before such an operation, described in Ch. I., Vol. I., should be adopted, while in addition it is of great importance to see that the patient's mouth is clean and aseptic and all septic teeth previously removed. The best incision will be a vertical one, half an inch to one side of the midline, in which one or other rectus muscle is drawn outwards (paramedian incision). The stomach is exposed, the ulcer discovered and carefully examined, especially with regard to its position, size, fixity to surrounding structures, and the presence of adhesions, scarring, pyloric stenosis, hourglass constriction, and enlarged glands is noted (see pp. 625, 626). The ulcer usually can be detected by the indurated mass it forms, and the presence of white scars or thickening upon the peritoneum over it; the crater can sometimes be felt, while the posterior wall of the stomach must be carefully examined by opening the lesser sac, unless this is obliterated by adhesions. The ulcer is most commonly found :—

(*a*) At the pylorus;

(*b*) On the lesser curvature, in which case it may extend down both the front and back walls of the stomach (saddle ulcer); and

(*c*) On the posterior wall.

In those cases where a large mass of inflammatory tissue is present it may be difficult even when the ulcer is exposed to decide whether the mass is really due to chronic inflammation or is a carcinoma of the stomach. The cragginess, nodularity, presence of hard glands and of secondary growths in the latter condition may serve to distinguish it. This difficulty in discrimination doubtless accounts for the majority of cases where at operation what has been thought to be an inoperable carcinoma has been found, and yet afterwards the mass has disappeared and the patient lived for years.

As in all abdominal operations, having examined the ulcer, it is of the greatest importance to examine all the other abdominal organs. There should only be one abdominal operation in surgery commonly practised, and that should be an exploratory laparotomy. The procedure next to be adopted will depend upon the size and position of the ulcer and the views of the particular surgeon. Many operations are advocated for gastric ulcer, and we cannot here go into them or their pros and cons in detail. A short description of the operations will be found at the end of this chapter (pp. 640–650).

It must be remembered that, whatever operation is performed upon a gastric ulcer, it is highly probable that the patient will be much better, or even completely relieved of his symptoms, for a period of about six to eighteen months, but in many cases, after that time, a recrudescence of symptoms will occur. The operations in vogue for a gastric ulcer are as follows :—

(*a*) *Gastroenterostomy* (see p. 642). This is successful in duodenal ulcer, reasonably successful in pyloric ulcer, but *not* likely to give a high percentage of permanent cures in ulcers on the lesser curvature or the body of the stomach. The further the ulcer is to the left of the stomach the less likely is a gastroenterostomy to cure it, for the anastomosis should, if possible, lie to the left of the ulcer. The operation is especially suitable in cases where obstruction (pyloric stenosis, or hourglass stomach (see p. 625)) is present. It acts partly by allowing the food to leave the stomach rapidly at a dependent part of the stomach, partly by allowing the alkaline intestinal and pancreatic juices to enter the stomach and thereby diminish the gastric acidity, and possibly also partly owing to the fact that the large incision made in the circular muscle coat provides the ulcer with rest upon the same lines as in a gastromyotomy. It is not usually necessary to close the pylorus as is advisable in the case of a duodenal ulcer (see p. 636). Gastroenterostomy does not give good results in patients with a high gastric acidity. Sometimes a gastroenterostomy will render an ulcer which is too fixed to be removed removable at a later date.

(*b*) *Excision of the Ulcer combined with Gastroenterostomy.* The ulcer may be excised with a knife or the cautery (Balfour), or it may be infolded. It is said that by thus removing the ulcer the risk of a carcinoma starting at its edge is eliminated. The gastroenterostomy opening should be near to and parallel to the greater curve with its centre opposite the suture line. This operation is particularly useful in the case of ulcers well to the left of the stomach and near the œsophagus. There are, however, not many cases in which it is suitable. Excision of an ulcer without performing a gastroenterostomy gives poor results, and should not be practised.

(*c*) *Partial Gastrectomy.* A partial gastrectomy on the lines of that performed for carcinoma of the stomach (see p. 648), though rather less extensive, is nowadays advocated by many authorities for gastric ulcers of all kinds, more especially those which are not at the pylorus. There is little doubt that for ulcers on the lesser curvature and body of the stomach the results of this operation are better than those of gastroenterostomy. It has also the additional advantages that that portion of the stomach in which ulcers almost invariably occur (the " ulcer-bearing " portion) is completely removed, that the chances of carcinoma arising in the edge of the chronic ulcer are eliminated by the removal of the ulcer, and also that the formation of secondary ulcers (gastrojejunal and jejunal ulcers (see p. 620)) is very much less likely than after gastroenterostomy; we have, however, recently seen two after gastrectomy. The gastric acidity is also reduced. It must be remembered that it is a much more severe operation, and though certain authorities claim that its mortality is no greater than that of gastroenterostomy (see p. 634), this is a quite incredible statement. In the case of a small ulcer it involves removing an unnecessarily large amount of stomach. At times marked anæmia, or even pernicious anæmia, follows the removal of a large part of the stomach, possibly as the result of the loss of some gastric ferment. This is said to be less likely to follow Schoemacher's method of gastrectomy. We are opposed to its routine performance in all cases of gastric ulcer, but in many cases, where the ulcer is adherent or well away from the pylorus, it is an admirable operation. For a description of the operation, see p. 648.

(*d*) *Gastromyotomy.* This operation aims at giving the ulcer complete rest from the muscular movements of the stomach, and consists in cutting through the muscular coats of the organ without damaging the mucous membrane in a direction roughly forming a circle round the ulcer (see p. 648). We have performed the operation in a fair number of cases, and the results seem satisfactory, but it is very rarely performed now.

(*e*) *Jejunostomy* (see p. 628). This is reserved for very severe cases, where the ulcer is very large and eroding the liver or pancreas, *i.e.*, in cases where it is obvious that a gastroenterostomy will not help and a gastrectomy cannot be done, either because of the patient's condition or the fixity of the ulcer. It aims at giving the ulcer complete rest of all kinds by permitting no food to enter the stomach for some months. Great improvement usually follows.

(*f*) *Cholecystogastrostomy* (see pp. 650 and 763). It has been noticed that duodenal ulcer never occurs in the duodenum below where the bile enters, and it has been suggested, therefore, that admitting the bile to the stomach might cause a gastric ulcer to heal. Some small series of cases have been recorded in which the early results at any rate appear to be good.

(*g*) In the not uncommon cases where a large ulcer of the posterior surface is adherent to the pancreas, and the patient experiencing great pain, the ulcer may be freed from the pancreas and excised. The opening is invaginated and sutured and much relief of pain follows.

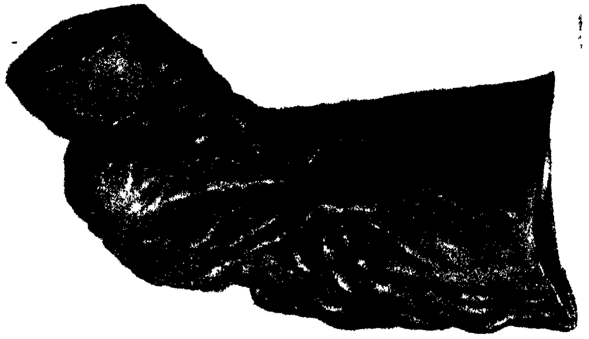


FIG. 221. Perforation of a chronic gastric ulcer. The stomach has been inverted so that the mucous membrane is on the outer side. The "stepped" shape of the ulcer crater is well shown.

Gastrojejunal and Jejunal Ulcer (Secondary Ulcer, Peptic Ulcer). These are conditions which sometimes occur after a gastroenterostomy has been performed, and consist in a chronic ulceration occurring either upon the anastomosis line (gastrojejunal ulcer), or else in the efferent limb of the jejunum 1 or 2 inches below it (jejunal ulcer). In the former case it is accompanied by the formation of a large amount of inflammatory tissue, which may give rise to a big swelling in the transverse mesocolon, and which becomes adherent to the transverse colon, pancreas or anterior abdominal wall. This condition is the commonest cause of a fistulous opening between the stomach and transverse colon (gastrojejunocolic fistula, see p. 628). These ulcers are said to be more common after anterior or en-Y gastroenterostomies, and have very rarely been seen after gastroenterostomy performed for carcinoma of the stomach. Though stated to occur in, roughly, 2 per cent. of cases, they are far more common. The cause is not known for certain, but it has to do with errors in the technique of the gastroenterostomy, and is due in all probability to the action of the acid gastric contents on the intestinal mucosa, while persistence of the original causes which led to the ulcer for which the gastroenterostomy was done undoubtedly plays a large part (see pp. 616 and 637). Inasmuch as ulcers on the fundus of the stomach usually have a much less acid gastric juice than those of the pylorus or on the duodenum, it is found that these secondary ulcers are most common after gastroenterostomies done for duodenal and pyloric ulcers. The use of unabsorbable ligatures or of clamps, the excision of pieces of mucous membrane and the formation of small hæmatomata in the suture line have all been blamed, while there is little doubt that the action of the acid gastric juice plays a considerable part in their production. They are especially seen in patients with a high gastric acidity. The condition may come on at any time within a few weeks or several years of the original operation, most commonly about a year or eighteen months afterwards.

The symptoms are very similar to those of the original gastric or duodenal ulcer, the pain coming usually two or three hours after a meal, rather more to the left and lower down, often about the level of the umbilicus, while there is tenderness and rigidity of the upper left rectus. A tender mass may be felt in some cases. An X-ray film probably will show rapid emptying of the stomach through both the pylorus and the stoma, but the bulbous excrescence suggestive of an ulcer crater is not usually detectable.

The complications of the condition consist of hæmorrhage and perforation, neither of which is common, and the symptoms of which are exactly similar to those arising when these complications occur in a gastric ulcer (see p. 622); also the formation of a gastrocolic fistula (see p. 628).

Treatment. The treatment consists in the first instance in medical treatment on the lines laid down for gastric ulcer. As this is not likely to be successful, in most cases operation will have to be performed.

The ulcer is exposed and it, together with the mass of scar tissue round it, is carefully dissected free from the transverse colon and mesocolon, without damaging either of these structures or the blood supply of the colon. This may be a very difficult procedure. The anastomosis and ulcer are then set free and removed, and this will necessitate excising a short piece of the afferent and efferent loops of bowel and a small portion of the stomach con taining the anastomotic opening. The parts are then repaired :—

(*a*) By an end-to-end anastomosis of the afferent and efferent loops and closing the openings in the stomach and transverse mesocolon. This does away with the gastroenterostomy and is by far the best procedure. It, however, can be performed only if the original ulcer has healed and the pylorus is patent.

(*b*) By restoring the continuity of the bowel and re-establishing the gastroenterostomy. This is open to the objection that it is quite likely that a fresh secondary ulcer will form upon the new gastroenterostomy.

(*c*) By an end-to-end suture to restore the continuity of the small bowel and a partial gastrectomy usually of the Finsterer type.

These operations are of considerable magnitude and difficulty ; the results are excellent.

Complications of Gastric Ulcer. (1) **Hæmorrhage.** This may arise from arteries, veins or capillaries, and when severe is due to the ulcer eroding a moderately large vessel. This latter condition usually occurs in chronic ulcers, especially those on the posterior surface eroding the pancreas, in which case the splenic or pancreaticoduodenal arteries may be opened. In acute ulcers the bleeding is usually capillary and not serious. It is of greater significance in men than in women, where it may take the form of a generalised oozing from the mucous membrane.

The blood is usually vomited at repeated intervals, when it appears dark in colour. The patient complains of pain and discomfort, the pulse becomes rapid and soft, while pallor and sweating are marked. After a few hours the blood acts as an aperient and large, black, tarry stools will be passed (melæna). Such hæmorrhages are often very severe and much blood is lost, but the hæmorrhage from a gastric ulcer is usually less severe than from a duodenal ulcer and the former variety is rarely fatal.

Treatment. The treatment of this condition is entirely medical, and an operation to stop the hæmorrhage should not be countenanced, except in very desperate circumstances as when hæmorrhage recurs rapidly and repeatedly. The patient should be absolutely quiet and be kept flat in bed, given large doses of morphia and nothing whatever by the mouth for several days except ice to suck. Injection of 10 c.c. of 30 per cent. sterile sodium citrate into a vein often arrests the hæmorrhage when all other means have failed to do so. Rectal feeding may be indulged in in small quantities, and care must be taken not to raise the blood pressure. In recurrent cases blood transfusion may be necessary by a slow continuous drip; this diminishes the risk of a sudden rise of blood pressure, and consequent recurrence of the hæmorrhage, which may occur with a rapid transfusion.

After a severe hæmorrhage of this kind it is probable that others will occur at a later date. One severe hæmorrhage, therefore, or repeated small hæmorrhages are strong indications that an operation to cure the ulcer should be performed (after the hæmorrhage has ceased).

(2) **Perforation.** This is a common and grave complication most usually seen in men, but neither sex and no age are exempt; the oldest we have seen being seventy-eight and the youngest eleven years. A perforation is usually upon the anterior wall and generally near the pylorus or on the lesser curvature; in young people it is sometimes at the cardiac end. More than one simultaneous perforation has been described, but multiple perforations are very rare. It varies in size from a pin-prick to an opening as large as a sixpence. The tissues for ½ inch around are usually œdematous, swollen and covered with flakes of lymph, while the amount of surrounding induration and hardness will depend upon the condition of the ulcer previously. In acute ulcers very little induration is present.

Immediately after perforation gastric juice and food matter escape into the peritoneum and run down to the pelvis, usually in front of the omentum, giving rise to intense irritation. As a result fluid is poured out by the peritoneum, at first clear in character, but soon containing flakes of lymph, which make it yellowish, while recognisable food materials may be seen in it; the odour of whisky or gin can sometimes be detected upon opening the abdomen. For some hours the peritoneum is in an acute state of irritation, but after eight or ten hours infection sets in and peritonitis gradually supervenes, with its classical pathological appearances (see p. 535). The fuller the stomach and the bigger the perforation, the more severe the symptoms and the worse the prognosis. In a few cases the ulcer is on the back of the stomach, and the pathological changes are then confined for some time, at any rate, to the lesser sac.

These perforations are of three main varieties:—

(*a*) When a reasonably large perforation occurs on a free surface, so that the general peritoneal cavity becomes involved—*acute perforation.*

(*b*) Where only a very small leak occurs and the stomach is, perhaps, empty so that the swelling and outpouring of lymph limit the extravasation to a small area close to the opening, and the general peritoneal cavity is not involved—*subacute perforation* or *leaking gastric ulcer.*

(*c*) Where the perforation occurs into a space shut off by adhesions. There is no extravasation and no involvement of the general peritoneal cavity—*chronic perforation.* This gives rise to the formation of a perigastric abscess and is described on p. 624.

Clinical Features of an Acute Perforation. In most cases there is a previous history, at any rate for a few weeks, usually for much longer, characteristic of a gastric ulcer, though in a few instances the perforation comes without warning. It is not uncommon to find that for a few days or weeks before the perforation there has been an exacerbation of the previous gastric symptoms.

There is a sudden onset of intense, continuous, burning, stabbing pain of the most excruciating type, situated first of all in the epigastrium over the ulcer, but soon radiating all over the abdomen, and especially down whichever side of the abdomen the ulcer lies. It also radiates to the hypogastrium. The patient may fall down or cry out with it, and nearly always lies still, flat on his back, and does not writhe about, as movement appears to make the pain worse. At times there is " phrenic pain " referred to the tip of the shoulder and due to irritation of the diaphragm and crus. This is often bilateral. He may vomit once or twice, but not profusely, and often will state that the pain has come on immediately after a meal or during some slight exertion. He rapidly passes into a condition of considerable shock, with pallor, coldness, subnormal temperature, and a pulse which is thin, hard and wiry, but, for the first hour or two at any rate, frequently slow ; this should be noted especially. The larger the perforation and the fuller the stomach the greater the shock will be, and some cases have died of shock within an hour or two of the onset. On examination the abdomen is acutely tender, especially over the ulcer, respiratory movements are absent, while all the abdominal muscles are as rigid and hard as a board, their tight contraction often causing the abdomen to retract and sink in to assume a carinated appearance. The patient's respiration is jerky and shallow, and his speech often difficult. The liver dulness frequently disappears within a few hours, though this is an unreliable sign, and the abdomen may exhibit a peculiar, high-pitched tympanitic note due to the presence of a mixture of air and fluid within it.

After two or three hours a reaction sets in ; all the symptoms become slightly less marked, the pain and tenderness become better, probably owing to the dilatation of the gastric fluids by peritoneal exudate. The intense rigidity, however, persists, and the pulse now rises and becomes more and more rapid, so that there should be no excuse for being deceived by the patient's apparent improvement.

After six or eight hours peritonitis begins to set in and the patient gets worse, the pulse becoming more and more rapid, profuse vomiting commences, the pain becomes generalised, and the face anxious. Rigidity and retraction become replaced by distension of the abdomen, the *facies Hippocratica* develops, and if the perforation is untreated death occurs within three days (see also p. 537).

In the cases where only a subacute perforation or leak has occurred the onset is equally sudden, but shock is not present, and the signs and symptoms remain localised to a spot in the neighbourhood of the ulcer and are much less severe. General peritonitis does not set in, and if untreated resolution may occur, though a perigastric abscess is likely to form.

The differential diagnosis of the condition is discussed in Chapter XVII.

Treatment. The treatment consists in operation as early as possible; this is of the greatest urgency, and no medical treatment exists. It is, in a few instances, advisable to wait for one or two hours for the patient to rally from the initial shock, but such cases are very rare and every moment saved is of value. A paramedian incision on one side of the abdomen is made, and on opening the peritoneum, gas and a thin, yellowish watery fluid, with flakes of lymph and particles of food in it, will escape. The perforation is usually easily seen by noting where the gas and fluid come from, and by the flakes of lymph and induration in its neighbourhood. The rest of the abdomen is packed off, the ulcer is brought up as near the surface as possible, and the opening is closed if possible by an inner through-and-through catgut stitch and an outer Lembert inverting layer of stitches.

In some instances it will not be possible to suture the perforation owing to its size, situation, or to the stitches cutting out from the softened tissues, and then a small portion of omentum the size of half a crown should be cut off and sewn over the opening as accurately as possible. A few very large perforations will be seen in which even this is impossible, and then a tube should be put down to the ulcer with a plug round it and left in for a few days; some surgeons suture an omental graft on, as well as suturing the ulcer. The whole of the stomach, and the lesser sac, also should be examined in case another perforation is present.

Many surgeons advocate that after closing the perforation a gastro-enterostomy should be performed there and then as a routine. We are entirely opposed to this, except in those cases where the ulcer or the suturing of the perforation has produced a stenosis of the pylorus or of the stomach.

At the end of the operation no irrigation should be performed, but the peritoneum is emptied of gastric contents by means of suction or sponged as dry as possible with gauze mops, and the question of drainage will then arise. If the perforation has occurred less than twelve hours before, there is no need to drain the abdomen, but in cases of longer duration than this a drainage tube had better be introduced through a separate stab wound into the pelvis. The after-treatment is that of gastric operations in general, special attention being paid to keeping the patient upright in the Fowler position; small quantities of water should be given by the mouth from the first, and the general lines indicated in Vol. I., Ch. I., followed.

The complications which may follow the operation are those of any other acute abdominal operation (see Vol. I., Ch. I.), but in these cases there is special liability to the development of pneumonia, empyema and subphrenic abscess. Residual abscesses elsewhere in the peritoneum are also seen.

Prognosis. Without operation less than 3 per cent. of cases recover. If the operation is undertaken within ten hours recovery is highly likely, up to fifteen hours it is reasonably likely, but after eighteen hours it is uncertain.

After a successful recovery from a perforation all symptoms of the ulcer nearly always disappear for from six to eighteen months, and the patient appears to be completely cured. After this time, however, further pain and ulcerative symptoms may supervene; the patient is then back in the condition he was before his perforation and further treatment will be required. We do not however consider this sufficient reason for performing a gastro-enterostomy at the time of the perforation.

(3) **Perigastric Abscess.** This is usually the result of the so-called chronic

perforation of the stomach, where a leakage is limited by adhesions and a localised abscess results, which lies in the peritoneum and is more or less in the subphrenic region. The abscess is usually found under the left vault of the diaphragm ; occasionally it is in the lesser sac.

Such a patient often gives a characteristic history of an ulcer, and also that some days before a sharp attack or exacerbation of symptoms has occurred. After a few days the temperature and pulse rise, and a tense, tender, rounded swelling appears in the epigastrium. As the abscess may contain gas the swelling is frequently resonant, while the patient emaciates rapidly and becomes seriously ill. If not properly treated such an abscess may burst into the peritoneum and cause peritonitis, may pass through the diaphragm and cause an empyema, may burst into the lung and be expectorated, or may burst through the anterior abdominal wall. In this case it is likely to be followed by a gastric fistula (see p. 627). In other instances it has burst into the colon and given rise to a gastrocolic fistula (see p. 627).

The treatment of a perigastric abscess consists in opening and draining it as soon as possible ; nothing else should be done at the time, but further treatment may be necessary later should a fistula supervene or for continuation of the ulceration.

(4) **Perigastric Adhesions (Perigastritis).** Nearly every case of chronic ulcer gives rise to adhesions between the stomach and surrounding parts. In most cases these cause no symptoms, and in many cases they are beneficial in limiting the ulcer and preventing perforation, but in other instances they produce deformity and stenosis of the pylorus or stomach (see below), while they may delay the healing of the ulcer or give rise to disease in neighbouring organs, such as the gall-bladder. Those ulcers which are adherent to the pancreas give rise to especially violent pain. Their treatment is that of the gastric ulcer, with which they are associated, while it must be remembered that they will render operative interference considerably more difficult.

(5) **Pyloric Stenosis and Hourglass Stomach.** Cicatricial stenosis and contraction are frequently produced by the healing and fibrosis of large ulcers. They are rarely seen in acute ulcers, but may be very marked in cases of chronic ulcers of old standing. They are usually seen in three situations :—

(*a*) Near the œsophagus, where they produce dysphagia and difficulty in swallowing, with regurgitation of food similar to that appearing in an œsophageal stricture.

(*b*) On the body of the stomach, where they cause **hourglass stomach.** Here the contraction may be very exaggerated and is usually the result of a very chronic saddle-shaped ulcer on the lesser curve, involving both sides of the stomach. Surrounding adhesions help to constrict the stomach, which gradually becomes deformed into two separate compartments connected by a narrow opening usually about 4 inches from the pylorus. The greater curvature appears to be drawn up towards the lesser, while the upper pouch is usually the larger, lying behind the left costal margin, the lower one only being obvious below the ribs. It must not be forgotten that carcinoma of the stomach and perigastric adhesions may cause a similar condition. The portion of the stomach above the constriction becomes both dilated and hypertrophied.

Clinical Features. The condition is far more common in women and is usually preceded by a history of gastric ulcer for many years. The pain gradually becomes more continuous, vomiting becomes more marked and the vomited fluid more foul. Finally, the patient vomits at intervals of twenty-four to forty-eight hours very large quantities of foul, frothy, partly digested food, so that the condition closely resembles pyloric stenosis (see below). Succussion splash will be present; visible peristalsis, passing from left to right, is occasionally seen. Tetany is sometimes seen in association with this condition.

An X-ray examination with a barium meal almost invariably demonstrates the condition, and is so certain a means of diagnosis that such accessory tests as distending the stomach or washing it out with a known quantity of fluid, which is measured on its return, are quite unnecessary. Care must be taken to exclude a functional spasm of the stomach in the X-ray film. It must be remembered that the condition frequently coexists with pyloric stenosis (see below).

Treatment. This is essentially surgical, as no medical treatment is of benefit. The abdomen is opened, and the actual procedure adopted will depend upon the nature of the constriction. In a few cases where the constriction is central, a gastroplasty, performed in a manner similar to a pyloroplasty (see p. 650), or to Nelaton's operation for hare lip (see p. 154), can be performed. This is not usually satisfactory, and better results will be obtained either by a circular sleeve resection of the central part of the stomach, containing the stricture, followed by end-to-end anastomosis, or by anastomosing the two pouches together below the stricture, gastrogastrostomy. In many cases where active ulceration appears to have ceased a simple gastroenterostomy performed into the upper pouch will produce a cure; but care must be taken that the upper pouch is selected, as the lower division has before now been mistaken for the whole stomach. In the fairly common type of case, where the condition coexists with a pyloric stenosis, none of these procedures will be sufficient. Here either a gastrogastrostomy, combined with a gastroenterostomy into the distal pouch, or a double gastroenterostomy one into each pouch, or a partial gastrectomy will be necessary.

(*c*) **Pyloric Stenosis.** This is a common condition as a sequel of an ulcer. The muscular coat of the stomach becomes hypertrophied, but after a time the stomach dilates and becomes huge in size, reaching even down to the pubes, while the food collects there for days and ferments, and it is at this point that symptoms commence. The patient will give a history for many years pointing to gastric ulcer; more recently the pain has become more continuous and the vomiting more profuse and not related to meals, until finally, at intervals of one or two days, he vomits quantities of partly digested, frothy, foul-smelling food. Rapid wasting occurs and constipation is marked. On examination there will be signs of a grossly dilated stomach with succussion splash, and visible peristalsis passing from left to right, while the X-ray appearances are absolutely characteristic. This condition also is sometimes accompanied by tetany.

Though the majority of these cases are due to the healing of a gastric ulcer, spasm of the stomach plays a part in increasing the symptoms. Other cases are due to the contraction of perigastric adhesions; not infrequently carcinoma is the cause of the obstruction (see p. 631), while there is a rare congenital type occurring in infants (see p. 628).

Treatment. Though the condition may be relieved and the symptoms palliated by careful washing out of the stomach, operation is the only means of cure. This should consist of a simple gastroenterostomy. There is no class of case in which gastroenterostomy provides a more complete or more dramatic cure, so much so that we have no sympathy with those who advocate a formal partial gastrectomy for pyloric stenosis. Finney's operation is also suitable for these cases provided there is no large mass of scar tissue round the pylorus and if all ulceration has healed.

Gastric Tetany. It is in cases of gastric obstruction where much dilatation, stasis and fermentation occur that tetany is occasionally seen. This takes the form of hyperexcitability and fibrillary twitchings of the muscles, with spasms or cramps of the hands and feet, the hands in particular taking up a characteristic position, with the fingers and thumb indrawn to form a cone. The cause of this condition is unknown, but it is considerably more common to see tetany in association with gastric conditions than in thyroid conditions.

The treatment consists in relief by washing out the stomach with a weak solution of permanganate of potash, while it is an indication strongly pointing to operative cure of the gastric obstruction.

Acute Dilatation of the Stomach. This is a serious and rare condition which is most commonly met with following an abdominal operation, especially one on the upper abdomen. It is occasionally seen after other operations and sometimes arises as a terminal condition in wasted and weak patients. Its cause is unknown, but the stomach and duodenum rapidly become greatly dilated and unable to empty themselves, peristalsis being absent. Ulceration and erosions of the stomach may occur rapidly and give rise to a blood-stained vomit. Personal idiosyncrasy may play some part in it as it has occurred in the same patient several times after different operations. The stomach becomes elongated and V-shaped with a thin and even translucent appearance. It has occasionally set in suddenly during an abdominal operation. The epigastrium and upper abdomen become full, the stomach resonance enormously increased, and there is vomiting of profusely large quantities of greenish watery fluid, with intense thirst and restlessness. After a time the vomit may become brown and foul. In spite of this continuous overflow from the stomach the distension is not relieved. The patient becomes exceedingly ill, with a small and rapid pulse, and usually dies within a few days. Pathological theories to account for it are :—

(*a*) That it is a toxic condition, due possibly to septic absorption, in which the anæsthetic and handling of the stomach may play some part.

(*b*) That it is due to a combined vagus and sympathetic paralysis, and may be analogous to paralytic ileus (see Vol. I., Ch. XII.).

(*c*) That it is due to the downward drag of the superior mesenteric artery, which may press upon and constrict the duodenum.

(*d*) That the descent of the grossly dilated stomach may kink and obstruct the third part of the duodenum.

Treatment. In the first instance the stomach should be washed out frequently, while the patient may be nursed lying upon his face. Absolute rest must be given to the stomach. Morphia is valuable and a drachm of adrenalin in an ounce of water should be given every hour for six or eight doses. Gastroenterostomy or gastrostomy to provide drainage of the stomach is sometimes beneficial. Stimulants will be necessary, while the patient should be laid flat upon his face, or placed in the knee-elbow position at intervals to relieve the gastric descent.

Gastric and Gastrocolic Fistula. These are two distressing conditions which are occasionally seen as complications of certain diseases of the stomach.

(*a*) *Gastric Fistula.* This is usually the result of either a perigastric abscess, which has been opened or burst spontaneously, a wound of the stomach, or a gastric ulcer or gastrojejunal ulcer which has involved the anterior abdominal wall. It is sometimes the result of a carcinoma or a badly performed gastrostomy. Gastric juice escapes from the fistula, and the nearer this is to the pylorus the greater the escape. The skin rapidly becomes digested, and the tissues round intensely sore and irritated. If large quantities of food escape the patient will waste, but this is not usual except in pyloric and duodenal fistulæ.

Small fistulæ probably will heal on their own, especially if the patient is fed by the rectum for a few days. Should this fail the abdomen will have to be explored, and the cause of the fistula found and dealt with. The skin must be protected with greasy ointment and dressed with an alkaline solution.

(*b*) *Gastrocolic Fistula.* This is usually the result of a secondary gastrojejunal ulcer (see p. 620) and is better named a gastrojejunocolic fistula. It is rarely caused by carcinoma of the stomach or a perigastric abscess. It is a distressing condition, in that the patient complains of foul, fæcal-smelling eructations, and may vomit semisolid fæcal matter. In addition to this diarrhœa is pronounced, especially of a lienteric type, which comes on immediately after a meal and contains much undigested food. The stomach cannot be distended with air, while a bismuth meal will demonstrate the condition at once. Rapid wasting of the patient usually occurs.

Treatment is urgently demanded, and consists in operation by means of which the stomach and colon are exposed and separated by careful dissection. The two openings into them are then sutured independently. In many instances the causative condition will have to be removed, and this will often involve removing a portion of stomach and jejunum (see p. 619).

Gastroptosis. This is a common condition in which the stomach is prolapsed downwards, so that its pyloric end is at a much lower level than usual. It is nearly always associated with a general visceroptosis (Glenard's disease, see p. 655), so that the liver, right kidney, and other viscera are also at a lower level. The effect of the sagging is to render it difficult for the stomach to empty, and as the condition is accompanied by hypotonicity of all the musculature, considerable dilatation of the stomach usually occurs also. When standing up the patient appears pot-bellied, and the stomach can be seen to stand out prominently, while a bismuth meal will demonstrate the condition at once. The symptoms are usually those of visceroptosis (see p. 655), *i.e.*, vague epigastric pain, worse on exercise, and better after rest, with succussion splash, acid eructations, constipation, and loss of weight. They are accompanied usually by a considerable amount of neurasthenia. Gastric acidity is usually diminished and hæmatemesis occasionally occurs. There is no visible peristalsis.

Treatment. The treatment is that of visceroptosis and neurasthenia in general, and consists in massage and electrical treatment and the wearing of a proper abdominal belt, which must be put on while the patient is in the recumbent position, Curtis' abdominal support being by far the best if the patient will wear it. Dieting and gastric lavage are to be avoided if possible, as increasing the neurasthenia.

Many operations have been devised for this condition, which consist in supporting the stomach in various ways (gastropexy, Rovsing, Beyea), or diminishing the size of the stomach by suturing it (gastroplication). They are all equally futile and undesirable. *On no account whatever should a gastroenterostomy be performed.*

Congenital Hypertrophic Pyloric Stenosis. This is an uncommon condition met with in tiny infants, usually males who are breast-fed (85 per cent.), and frequently the first children of intellectual parents. It has been recorded in adults, but this is very rare and in most cases there is a record of similar trouble in babyhood. There is marked hypertrophy of the circular muscle of the pylorus, the pylorus in a baby four or five weeks old taking the form of a shining white tumour the size of the terminal joint of the thumb, consisting almost entirely of true muscle tissue without any fibrosis, and feeling very hard, with a sharp division from the duodenum. This produces very marked stenosis of the passage, while the mucous membrane is thrown into folds and further obstructs it. As a result of the obstruction the whole stomach becomes enlarged and hypertrophied. Theories as to the cause of this condition are numerous :—

(*a*) That it is due to over-action of the sympathetic in some way connected with suprarenal activity.

(*b*) That there is a persistent spasm of the pylorus, which leads to hypertrophy of the muscle.

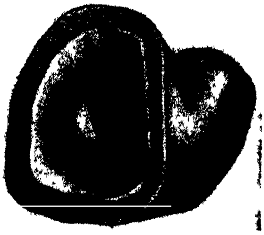


FIG. 222. Congenital hypertrophic pyloric stenosis, showing the pyloric mucosa pouting into the duodenum.

(*c*) The most probable theory is that there is some inco-ordination of the neuromuscular apparatus, so that the pylorus fails to dilate, the condition being exactly analogous to the achalazia seen in the œsophagus ; similar states are occasionally seen at the ileocæcal valve and at the pelvirectal junction (see Vol. I., Ch. XII.).

The baby is perfectly healthy for a few weeks and usually a particularly fine child. Symptoms come on almost always between the third and fifth weeks, and consist of intractable, persistent vomiting of an expulsive kind, more resembling the vomiting of an adult than an infant. The vomit is almost immediately after feeding, is explosive and expelled some distance, and consists of food and mucus ; it never contains bile ; rarely there is hæmatemesis or coffee-ground vomit. It does not occur after every feed. The infant rapidly emaciates and constipation is marked, the stools being slimy and scanty, like those before the milk stools are established. The facies may be characteristic, with a furrowed brow, pale thin cheeks and prominent sucking pads. The lip reflex is very brisk, the fingers are sucked and the appetite appears enormous. After a short time waves of gastric peristalsis can be seen passing from left to right and ending at the pylorus, while in many cases a tumour can be felt in the position of the pylorus, and may be noticed to harden and soften at intervals ; this may need careful and frequent examination for its detection. A bismuth meal can be given through a rubber catheter with perfect safety and will demonstrate the condition. The symptoms sometimes exhibit a curious intermittency.

Treatment. A few cases are improved by change in the diet or by repeated lavage of the stomach ; circumcision is said to have cured others, but these cases are probably due to spasm of the pylorus rather than to true obstruction. Recently the use of atropin in the form of humidin has been reported as effecting successful cures. These methods should be tried for a short time, but if they fail, and before the child becomes emaciated, operation will be necessary.

The old operations, such as gastroenterostomy, dilatation of the stomach by Loreta's method, pyloroplasty, etc., have all been entirely replaced by Rammstedt's operation. The abdomen is opened by an incision high up on the right side over the liver. The advantage of this is that when sewing up the wound (always a difficult thing to do in a baby who may be straining) the liver will come down and keep the abdominal contents inside. The pyloric tumour is brought out, and a single longitudinal incision made through all the muscle fibres till the mucous membrane appears and pouts out. Care must be taken not to damage this latter structure. No stitch is introduced in the pylorus and the abdomen is closed. The operation takes only a few minutes; it has a mortality of from 5 to 10 per cent., but gives excellent results. It is occasionally followed by hyperpyrexia or by severe diarrhœa for some days. Afterwards the children appear to grow up healthy and fit, and, like those affected with asthma and tuberculosis, appear to be above the average in intelligence. If for some reason or other no operation is done, and the child lives, the symptoms tend to clear up about the sixth month.

We have come across a few cases of young adults with chronic gastric pain and vomiting, where on operation what appears to be a congenital narrowness of the pylorus has been found with the remains of a tumour. This probably represents the end results of infantile cases which have survived but not been treated. It is easily relieved by a gastroenterostomy.

Gastric Fibromatosis (Leather-bottle Stomach). In this condition the submucous coat of the stomach undergoes what appears to be extensive fibromatosis. The condition is rare. It may be the result of syphilis, or some unknown toxic condition, while it is sometimes associated with a chronic gastric ulcer. Most commonly, however, it is a very fibrosed and scirrhous type of carcinoma (see p. 631). The stomach becomes converted into a firm, hard, contracted tube, about half its proper size, while the peritoneum over it is particularly white and thick. On section its wall is half or even one inch in thickness, the increase in bulk lying chiefly in the submucous layer.

Clinically the symptoms are those of very vague gastric disturbance, pain and vomiting, while only small amounts of food can be taken without causing a feeling of fulness. Unless a palpable tumour can be felt the condition is not likely to be diagnosed except by means of X-ray examination. Quite apart from the fact that a great many cases are malignant, the only treatment consists in a gastrectomy, which sometimes may be partial but often will have to be complete.

Volvulus of the Stomach. This is a rare condition occurring in middle-aged people. It may be partial or total, while the stomach may rotate round either its horizontal or a vertical axis, and there is considerable displacement of the colon, spleen and pancreas. The condition is usually associated with and probably caused by (1) diaphragmatic hernia or openings in the mesentery; (2) lesions of the stomach such as growths or adhesions, and especially hourglass deformity; (3) marked ptosis; (4) at times it appears to be entirely idiopathic. There is little interference with the circulation and gangrene has not occurred. The rotation naturally closes the pylorus and marked distension occurs. Overloading of the stomach, or possibly severe vomiting, may play a great part in causing the condition.

Clinical Features. There is sudden severe pain in the epigastrium and back. Vomiting (of stomach contents only) is marked, and after a time this ceases, but uncontrollable retching sets in, which is very characteristic. Inability to swallow occurs, and all food is returned at once. Epigastric distension is very marked. Thoracic pains and displacement of the apex beat may be seen, while a stomach tube cannot be passed. It will be seen that the clinical features are usually characteristic enough to enable a diagnosis to be made.

Treatment. Laparotomy must be performed at once. It may at first be difficult to discover the exact state of affairs, and it is usually impossible to reduce the volvulus until the gas has been withdrawn from the distended stomach by aspiration. The opening in the stomach is closed at once and the volvulus untwisted. Some form of gastropexy may be advisable to prevent a recurrence.

Diverticulum of the Stomach. A fair number of cases have been described in which small diverticula of the stomach wall are present, usually at the cardiac end and on the posterior surface. They have given rise to vague symptoms resembling a gastric ulcer, sometimes with hæmorrhage, and have been discovered on X-ray examination. Two types appear to exist:—

(1) Congenital—where all coats of the stomach exist in the diverticulum.

(2) Acquired—where no muscle coat is present. These are the commonest type and seem to consist of a hernia of the mucous membrane at a spot where the muscle is weak and the fibres widely spaced. Some of these may be traumatic. If the opening is small, retention of food will occur in the diverticulum and lead to decomposition and inflammation. The diverticulum is impalpable and only discoverable by X-ray examination.

Treatment. Many of these diverticula require no treatment, but if causing symptoms they must be removed by operation.

NEW GROWTHS OF THE STOMACH

Gastric Carcinoma. Nearly all growths of the stomach are carcinomata. The complaint is exceedingly common and is equally seen in either sex, no age between twenty-five and seventy being exempt. It is the commonest form of carcinoma in the male and in the female is only superseded by the breast and uterus. Some authorities state that it starts in a pre-existing chronic ulcer in a large number of cases (variously given as 3 to 75 per cent.), but it is more likely that this only occurs in about 10 per cent. of instances (ulcer-cancer) (see p. 616). Investigation by the British Medical Association in this country failed to reveal any definite case of carcinoma starting in a gastric ulcer, though we have personally seen fifteen or twenty in which it was quite clear microscopically and macroscopically that this had occurred. The most recent figures tend to show that probably 10 per cent. of ulcers become carcinomatous and 17 per cent. of carcinomata of the stomach have arisen in ulcers.

Pathology. Most commonly the tumour commences near the pylorus and in the neighbourhood of the lesser curvature, but the fundic end is by no means exempt. The growth may be spheroidal-celled or columnar-celled in type, the former being the more common and usually occurring on the fundus of the stomach, while the latter is more commonly seen at the pyloric end. A few growths at the œsophageal end have clearly spread down from the œsophagus and are squamous in type. A considerable degree of fibrosis is often present, especially in the pyloric part, so that the growth is sufficiently hard and nodular to be described as a scirrhus, and colloidal degeneration is not uncommon. These growths are nodular and papilliferous in type, with early ulceration. In some of them the papilliferous element is not marked, and then the gastric surface of

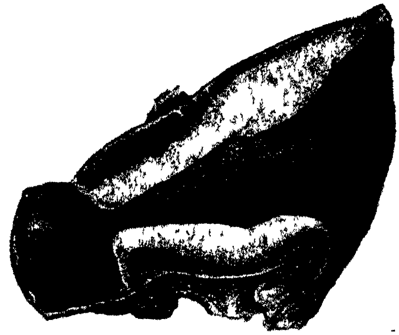


FIG. 223. Carcinoma of the pylorus, showing the invasion of the submucous layer and the freedom of the duodenum.

the growth is occupied by a hard, craggy ulcer with a raised everted edge. The fibrous nature of the pyloric growths, together with their slow growth, tends to constrict the lumen and produce pyloric obstruction. Here the disease shows no tendency to spread into the duodenum, but it extends along the lesser curvature. In other cases pyloric obstruction may be due, not to constriction and fibrosis, but to the proliferating mass of the growth. The growth does not often cause an hourglass stomach. It is in the submucous layer of the viscus that the carcinoma spreads most extensively, as this is where the lymphatics chiefly run, but in time all the coats become involved. When the peritoneal coat becomes involved, adhesions, ascites and diffuse secondary growths all over the peritoneum and omentum rapidly set in. These adhesions soon anchor the growth and may fix it to the liver, pancreas, colon, or even the anterior abdominal wall, so that not infrequently there is a huge mass in which several viscera are inextricably mixed up. In a few instances a diffuse carcinomatous infiltration of the whole stomach gives rise to a leather-bottle stomach (see p. 630).

The lymphatic spread of the growth is important. From the pylorus the growth runs along the lymphatics to the lesser curvature and reaches the glands in the neighbourhood of the coronary artery. It spreads to a lesser extent along the greater curvature, while the glands behind the pylorus and upon the pancreas also become involved. Subsequent to this the glands in the hilum of the liver become invaded and soon the liver itself is involved. These growths in the stomach are naturally in a septic condition from the first, and a considerable amount of the glandular enlargement may be due to sepsis and not to carcinoma. In a few instances the growth has spread up through the mediastinal lymphatics or the thoracic duct and given rise to a characteristic malignant enlargement of the lymphatic glands at the root of the neck on the left side (*Virchow's gland*). Apart from this it is rare to see metastases in distant parts of the body, though widespread peritoneal involvement nearly always occurs before the end. The early signs of peritoneal involvement are often found in the form of a few nodules in the pouch of Douglas, which seem to be due to cells having dropped off the main growth and become transplanted across the peritoneum (transcœlomic implantation). The growth must be regarded as of a moderately malignant type.

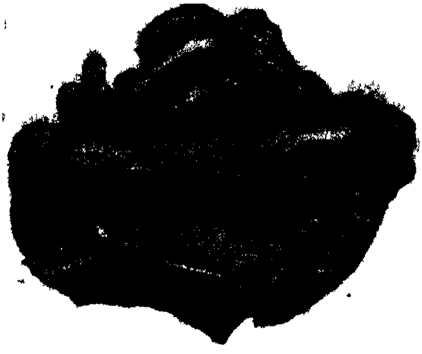


FIG. 224. Carcinoma of the pylorus with invasion of near-by glands

Certain complications occasionally occur. Pyloric obstruction is common, hourglass stomach rare, as also are perforation, perigastric abscess or gastric fistula. Empyema, as the result of involvement of the lung or pleura, is sometimes seen.

Clinical Features. In most cases the early symptoms are vague and indefinite, often taking the form merely of slight indigestion, anæmia, weakness or wasting. Every case of indigestion, therefore, commencing after the age of forty should be regarded with considerable suspicion. Failure of appetite (especially for meat), loss of weight and epigastric pain may each be the first symptom, and all supervene sooner or later. The pain is not particularly related to food, though it shows some tendency to be made worse by meals. Acid belching, marked anæmia and vomiting soon set in, the latter often not relieving the pain, while it is not usual for the vomit to contain blood; it occasionally, however, resembles coffee grounds. The tongue is usually clean. In some cases the anæmia is so marked and the patient of such a lemon colour that pernicious anæmia is simulated.

Careful abdominal examination must be made by the usual methods. It cannot be insisted upon too strongly that the presence of a palpable lump is a late sign, probably meaning that the growth is inoperable, and the surgeon must endeavour to diagnose his cases before a mass can be felt. Such methods of examination as inflation of the stomach with air and the examination of the gastric juice by means of a test meal are usually valueless, the latter especially, as by the time hydrochloric acid is absent the condition will be inoperable. They are rendered unnecessary by the extremely exact information which can be obtained by means of X-ray examination with a bismuth or barium meal. If a carcinoma is present this latter method will show that the motor power of the stomach is diminished; it may show obstruction and delay, while it usually will demonstrate a characteristic "filling defect" in the form of a bite or excavation out of the barium shadow caused by the growth. Pyloric obstruction, if present, will be demonstrated also. Microscopic examination of the vomit occasionally will show pieces of growth in it. Slight differences in the symptomatology may occur according to where the growth is situated:

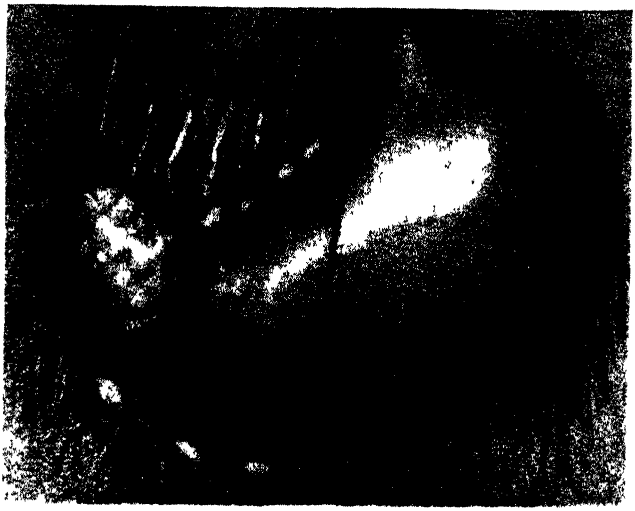


FIG. 225. Carcinoma of the stomach with enlargement of the glands, showing the portion of the stomach to be removed.

(*a*) *At the Cardiac End.* Here no tumour will be felt. Pain and difficulty on swallowing may be present and vomiting will be marked, the symptoms closely resembling those of carcinoma of the œsophagus.

(*b*) *At the Pylorus.* Here the indigestive symptoms are most marked. The vomiting becomes especially severe after a time, while in this situation a tumour is more likely to be felt. It will lie in the neighbourhood of the umbilicus, be hard and nodular, movable at first, later fixed, tender on pressure and possibly receiving transmitted pulsation. Such a growth sooner or later causes pyloric obstruction, when the stomach becomes dilated and the characteristic symptoms described on p. 626 are present. When this occurs loss of weight is very rapid.

(c) *On the Body of the Stomach.* Here the symptoms are particularly slight at first, while a tumour may or may not be felt. Such symptoms as there are, are nearly almost entirely indigestive.

As the condition advances the tumour becomes larger and more palpable, while it finally comes to consist not only of the stomach, but of adherent omentum, colon, liver, pancreas, etc. Pressure effects from either the primary or secondary growths will set in, and will give rise to jaundice, œdema of the legs and ascites. The latter condition may be due either to pressure upon the portal vein in the hepatic hilum or to the irritation caused by multiple growths studded over the peritoneum. Chylous ascites is occasionally seen, while early metastases may be discovered on rectal examination in the pouch of Douglas (see p. 632), or glands may be felt in the left side of the neck (see p. 632). Subcutaneous nodules are occasionally felt round the umbilicus.

In those cases where the carcinoma becomes grafted upon a simple ulcer the change in the symptoms is very slight and unnoticeable, and many of the characteristic features of a simple ulcer persist after the condition has become malignant.

We wish again to emphasise the fact that most cases where a lump can be palpated have passed already beyond the stage of radical removal, and it is only by exploratory laparotomy, when the symptoms and X-ray appearance seem to justify it, that cases are likely to be met with in an operable condition. The majority of cases are still encountered when this stage has been passed.

Treatment. The only possible treatment for this condition is its complete removal, together with its lymphatic drainage area. This is done by means of a partial gastrectomy as described on p. 648. In most cases the operation commences as an exploratory laparotomy in order both to make the diagnosis and to ascertain whether the growth is operable, and in any patient over forty, with persistent indigestion, which is not easily relieved medically, such an exploration is advisable. It is not possible to say until the abdomen is opened whether the growth is removable or not. The presence of glands in the hepatic fissure, of secondary nodules in the liver, in the pouch of Douglas, or elsewhere, of course render it inoperable, as also does fixity to the pancreas.

Fixity to and infiltration of the transverse colon in our opinion contraindicates operation, though this is not the opinion of all surgeons. The mere fact that the stomach is extensively involved does not necessarily contraindicate operation provided other structures are free, for the whole stomach has been successfully excised.

Those growths which are near the pylorus are the most suitable for excision. In the case of carcinoma of the body of the stomach, removal is sometimes, but not often, possible; it will have to be an extensive procedure. When the growth is near the cardiac orifice it is not likely that it will be removable.

In many cases where the growth cannot be removed temporary benefit may be obtained often by means of a gastroenterostomy. In patients who are weakly or feeble it may be possible to remove an operable growth by doing a gastroenterostomy first and removing the growth in ten days or a fortnight Billroth's second method). A gastroenterostomy is specially indicated when vomiting is marked, or when the pylorus is obstructed by the growth. It may be either anterior or posterior (see p. 645). This is often followed by cessation of vomiting, increase in weight, and marked improvement, but it probably does not produce a prolongation of life of more than three or four months, and is by no means free of risk. Cases will be encountered where on laparotomy the growth proves to be so extensive that even a gastro-enterostomy cannot be performed. Life may then be prolonged (if considered justifiable, which is unlikely) for a few weeks by means of a jejunostomy (see p. 698).

In a few cases, where the growth is high up near the cardiac opening, a gastrostomy may be beneficial.

Many cases are seen in which even a laparotomy is inadvisable; thus if a very large mass can be felt, if ascites or jaundice are present, or evidence of dissemination elsewhere, it is better not to advocate any operative procedure at all.

The ultimate prognosis after a successful removal is poor; very few patients live five years, and it must be remembered in this connection, as in all cases of carcinoma, that there is no time period after which a patient can be considered cured, as a recurrence may occur at any date.

In inoperable cases, as elsewhere, any recognised method of treatment, such as radium, X-rays, lead injections, etc., may be considered justifiable, though they are not in the least likely to do any good. Washing out the stomach, a careful diet, and administration of morphia will help to keep the patient comfortable.

Sarcoma of Stomach. This is a rare condition. The symptoms are similar to those of carcinoma, save that they occur in younger people, hæmatemesis is more frequent, and there is usually a big, round, elastic mass. The condition is usually fibrosarcomatous and amenable to operation. Its treatment is the same as that of carcinoma.

Simple New Growths. These are very rare; lipoma, fibroma, myoma, myxoma and adenoma have been described. They usually cause no symptoms whatever, but give rise to an easily palpable, round, smooth, movable tumour in the upper abdomen. This tumour is often pedunculated, and tends to drag the stomach down to the lower part of the abdomen, while characteristic changes will be seen in the X-ray film. The treatment consists in removal by operation.

THE DUODENUM

Foreign Bodies in the Duodenum. A body which passes through the pylorus, unless it is thin and elongated, *i.e.*, a hair-pin, usually passes through the duodenum satisfactorily. In this case its length may render the body unable to turn the corner of the duodenum; such bodies are usually found impacted at the junction of the second and third parts. If sharp they may slowly penetrate the duodenal wall and pass partly into the liver or pancreas. They give rise to few symptoms, except pain and vomiting, and usually can be demonstrated by means of X-ray pictures.

Treatment. This consists in laparotomy; the duodenum is incised, the foreign body removed and the opening closed in two layers. If the retroperitoneal portion of the duodenum is opened care must be taken to close the peritoneum over the duodenum. It may be possible to guide such a body down into the jejunum, as this is a safer portion of the bowel to open.

Congenital Duodenal Atresia. This is a rare condition, in which, owing to a developmental defect, a narrowing and more or less complete blockage occurs about the centre of the duodenum. The condition is usually seen in the neighbourhood of the bile papilla, where the foregut and midgut meet. The symptoms, therefore, occur in a recently-born child, and resemble those of congenital pyloric stenosis (see p. 628), save that they come on earlier, the vomit contains bile, and no tumour can be felt. The X-ray appearances also are different. The treatment consists in a gastroenterostomy. This must be performed as quickly as possible, and is a very serious procedure in a tiny infant.

Duodenal Diverticulum. This is also a very rare condition, where a congenital diverticulum occurs about the middle of the duodenum at its concave border, the wall sometimes containing a small portion of pancreatic tissue. The intestinal contents get into the pouch, which tends to increase in size and give rise to distension and vague upper abdominal symptoms. An X-ray photograph usually shows the condition. The diverticulum should be removed by laparotomy.

Ruptured Duodenum. The duodenum is one of the parts of the intestine which from its fixity is specially exposed to injury, and the duodenojejunal flexure is one of the most common sites for a rupture of the bowel to occur. This most commonly follows after a crush, " run over " injury, or blow in the epigastrium. The signs and symptoms of a ruptured duodenum depend largely upon whether leakage occurs into the peritoneal cavity or into the retroperitoneal tissues. In the former case they are those of rupture of the bowel in general (see p. 523), while in the latter case they are vague and misleading. In this latter case the accident is followed by a certain amount of shock, possibly vomiting and vague pain or tenderness in the epigastrium. In the course of some hours or days, as retroperitoneal cellulitis develops, the patient becomes worse, pulse and temperature rise, and an ill-defined, tender, epigastric swelling appears. Finally signs of suppuration, extravasation, and even surgical emphysema appear in the loins. The prognosis of a retroperitoneal rupture is very grave, partly because of the difficulty and delay in diagnosing it, and also because of the severity of the retroperitoneal cellulitis set up. It is usually at the subcostal angle that the early signs of retroperitoneal extravasation appear.

Treatment. The treatment of this condition consists in operation, to be performed as soon as possible. If the rupture is at the duodenojejunal flexure, severe hæmorrhage may be present; while if the rupture is retroperitoneal, œdema and extravasation of blood probably will be seen in the retroperitoneal tissues round the duodenum. In either case the tear in the bowel must be sewn up in two layers. This probably will occlude the lumen of the bowel, and there should be no hesitation in completely occluding the lumen if necessary; the operation can then be completed by performing a gastroenterostomy. The bile and pancreatic juice will pass back into the stomach, but this will have no evil effect. In retroperitoneal cases, diagnosed some days afterwards, the treatment probably will be confined to making openings in the loin to let out pus and extravasation. A very suitable position for drainage in this condition is in the left subcostal angle.

DUODENAL ULCER

Duodenal ulcer is a common condition which occurs in men, especially between the ages of thirty and fifty, usually in thin nervous people of the educated and professional classes, quite frequently in medical men. It is very rare in women in England, though in Scotland it appears to be more frequent in females. Taken all round, it is considerably more common than gastric ulcer, the chronic form of which it closely resembles in its pathological appearances, though there is less tendency to the formation of a deep crater. The ulcer almost invariably occurs within 2 inches of the pylorus, *i.e.*, in the first part of the duodenum, is almost always solitary, exhibits no tendency to become malignant and is surrounded by a considerable amount of induration. The cause is unknown, but is probably similar to that of gastric ulcer. Oral sepsis, the presence of infection in the appendix or elsewhere in the intestinal track, and possibly the nature of the blood supply to that part of the bowel, may all play a part in its formation, while it should be noticed that the ulcer nearly always appears at the spot where the acid chyme first strikes the duodenal wall. Actual trauma due to hot and spicy foods may play a part, while there is a good deal of evidence that deficiency of vitamin A is also a causative agent. The onset of acute duodenal ulcers has been described occasionally in association with extensive burns and other septic conditions (see Ch. IV., Vol. I.).

Clinical Features. This condition again is largely regarded as a matter of medical diagnosis. The patient complains of indigestion, taking the form of pain coming on two or three hours after meals or sometimes before the next meal, which is relieved by taking small quantities of food (hunger pain). The pain is gnawing, nagging, or sometimes acute and sharp, just to the right of the epigastrium and passing through to the back. The appetite is good, the tongue clean, flatulence absent, but acid eructations are often very trying. Vomiting is rare and does not often relieve the pain. The pain often comes on in the small hours of the morning, about 2 a.m., and wakes the patient. The symptoms show a remarkable intermittency, the patient often having two or three months of complete freedom, regularly followed by an equal period of severe symptoms. Spring and autumn are said to be the worst times and midsummer and midwinter the best times. In some cases the pain is intensely severe and colicky in nature, this probably being due to excessive duodenal peristalsis. In a few cases the ulcer is more or less latent, but suddenly, with very little warning, perforation or severe hæmorrhage will set in. On examination very little will be detected, except possibly a slight definite spot of tenderness and rigidity above and to the right of the umbilicus; hyperæsthesia is sometimes present also. Free hydrochloric acid is usually present in excess in a test meal, while the evidence of an X-ray examination will be of the greatest help. Irregularity or undue persistence of the duodenal cap may be seen, while in nearly all cases it will be found that the stomach empties abnormally quickly, or in a few cases pyloric spasm may give a picture resembling that of pyloric stenosis. The condition is, in a way, a more serious one than gastric ulcer, as both the complications of perforation and hæmorrhage are even more grave than in the latter condition.

The complications of a duodenal ulcer are very similar to those of a gastric ulcer and are described below.

Treatment. The treatment of duodenal ulcer is in somewhat the same position as that of gastric ulcer in that medical treatment frequently will relieve and occasionally cure the condition. This consists in rest in bed, alkalis and a strict diet as described in text-books on medicine. The liability to periods of freedom from pain and relapses is so great that it is difficult to say whether permanent cures are produced by this means.

Most cases, however, will require operative treatment. This is especially demanded in cases of pylorospasm or pyloric stenosis, in those where medical treatment has failed, in a few cases where an ulcer crater is visible in the X-ray film, and, above all, where there have been one or more hæmorrhages, while the treatment of the complications (see below) is essentially surgical.

A laparotomy is performed and the various abdominal organs carefully examined. A duodenal ulcer gives rise to a white puckered area on the duodenum, while an indurated mass of varying size may be felt. Care must be taken not to mistake the thickening round the normal pyloric ring for an ulcer. Adhesions often will be present between the duodenum, gall-bladder and other organs. If an ulcer is present a posterior gastroenterostomy should be performed, a large opening being made (see p. 634), while personally we always make a point of closing the pylorus at the same time. In order to do this it is enough to put a strong purse-string silk suture round the pylorus and tie it tightly. This will close the pylorus efficiently for about six months, at the end of which time the suture will pass into the bowel and the pylorus again become patent. This has, however, sufficed to give the ulcer complete rest. The only way of closing the pylorus permanently is to cut it completely across and sew the ends up, which is unnecessary. The operation of duodenectomy is being practised by some surgeons now for this condition. It is, however, a difficult and serious operation with a considerable mortality, and we are not convinced that its results are any better than the excellent ones which a gastroenterostomy gives in a duodenal ulcer in most cases.

Some surgeons have, however, found the results of gastroenterostomy unsatisfactory in their hands, and it must be acknowledged that the late results are better in cases with a low gastric acidity, and especially those where there is any degree of pyloric obstruction. In view of this, it is the practice of some operators to do a partial gastrectomy for duodenal ulcers, especially in the presence of a very high acidity. The ulcer is not removed and the pylorus and about an inch of the stomach are left behind. This portion of the stomach is closed and either a Polya or a Billroth No. 2 gastrectomy is performed. Such a gastrectomy is easier to do and has a smaller mortality than one for a gastric ulcer or a gastric carcinoma. This procedure benefits the ulcer in the following ways :—

(1) It prevents all food permanently from access to the ulcer ;
(2) It diminishes gastric acidity ;
(3) A supply of mucus from the pylorus passes over the ulcer ;
(4) There is no risk of regurgitation.

It will be realised that a rather smaller portion of the stomach is removed than is done for a gastric ulcer or carcinoma.

Complications of a Duodenal Ulcer. (A) **Hæmorrhage.** This is a common complication, which may vary greatly in severity. In some cases it is so slight that it can be recognised only by chemical examination of the fæces, while in other instances it is profuse and may endanger life. Most of the blood passes away in the form of melæna, though hæmatemesis will occur also. Such an attack usually occurs during an exacerbation of the symptoms, the patient suddenly becoming faint and pale with a rising pulse, often with an urgent desire to stool, but cases are seen in which the patient denies all previous history of indigestion. This condition is a more dangerous one than hæmorrhage from a gastric ulcer, as large vessels may become eroded. Though the hæmorrhage usually ceases, not a few deaths have been recorded from it. The patient should be placed flat on his back, while only ice by the mouth and large doses of morphia should be given. Should the hæmorrhage recur, an injection of 10 c.c. of 30 per cent. sodium citrate may be given intravenously. When the hæmorrhage is over and the patient has recovered from it, surgical treatment for the ulcer is urgently demanded. This should not be undertaken while bleeding is in progress except in the cases of severe repeated hæmorrhage. If this has to be done it should be immediately preceded by a blood transfusion.

(B) **Perforated Duodenal Ulcer.** Perforation of a duodenal ulcer is almost always acute. Chronic perforation is, however, occasionally seen into a localised cavity; this gives rise to a subphrenic abscess. An acute perforation is nearly always in the first part of the duodenum and much more common in the male than the female. A fair number of cases will be met with in which the patients deny all previous history of indigestion. The signs and symptoms are almost exactly those of a perforated gastric ulcer (see p. 623), except that the history is more that of duodenal than gastric ulceration, and the pain, tenderness and rigidity are even more marked on the right side than on the left side. The extravasated fluid tends to run down the right of the spine to the right iliac fossa, where it causes pain and tenderness, so that the condition is frequently thought to be acute appendicitis. General peritonitis is more common than in the case of gastric perforation, as the infectivity of the duodenal contents is higher. The prognosis is also rather worse and depends almost entirely on the interval between perforation and operation. Rarely retroperitoneal perforations of the duodenum are seen which give rise to less dramatic symptoms and which set up a virulent retroperitoneal cellulitis (see p. 636).

Treatment. The treatment consists in instant laparotomy, the abdomen being opened just to the right side of the midline in the epigastrium. Free gas occasionally escapes and the abdomen is found more or less full of an opaque yellowish fluid containing flakes of lymph and recognisable food-stuffs, similar to that found in gastric perforation, but in this case the effusion is sometimes bile-stained and neutral in reaction, so that it is less irritant. The fluid is found chiefly in the right side of the abdomen, but the pouch of Douglas soon becomes full. The perforation is found in the same way as already described on p. 624, though it is more deeply placed and more difficult both to find and to suture. It should be sutured in the same way as that described on p. 624, the suture line being placed transversely across the bowel, and care should be taken not to narrow its lumen. The remarks made on p. 624 with regard to the use of omental grafts, the necessity for performing a gastroenterostomy at the time, the advisability of drainage, the after-treatment and the post-operative complications apply equally well in this condition.

Duodenal Stenosis. This condition occasionally follows upon a duodenal ulcer, and gives rise to practically the same train of symptoms as those already described for a pyloric stenosis on p. 626. A properly performed gastroenterostomy or Finney's gastroduodenostomy produces a most satisfactory and dramatic cure.

Duodenal Fistula. This is a rare condition which is occasionally seen after an improperly treated perforation, after operations upon the gall-bladder where the duodenum has been damaged, or other operations where the duodenum has been incised. Duodenal contents escape rapidly, the skin round becomes digested and intensely sore and excoriated, while the patient rapidly emaciates. The condition is a serious one, and well may prove fatal from starvation. Operation to close the fistula by dissecting down to it and closing the opening by suture is the only treatment. This sometimes may have to be preceded by a jejunostomy to improve the condition of the skin round and to increase the patient's strength.

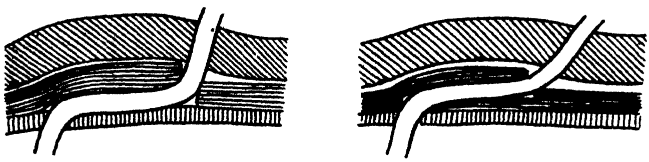
Carcinoma of the Duodenum. Though this is a rare condition, it is actually the commonest part of the small intestine for a carcinoma to occur. It is a columnar carcinoma, usually commencing in the neighbourhood of, and possibly actually from, the ampulla of Vater, and appears to bear no relation to duodenal ulcer. It thus produces symptoms both of duodenal obstruction and of biliary and pancreatic obstruction. An indication as to whether the growth is above or below the bile-duct may be obtained by noting whether the vomit contains bile or not. In a few cases such a growth has been excised successfully, but as a rule it is only possible to relieve the symptoms, *i.e.*, the duodenal obstruction can be relieved by a gastroenterostomy, and the jaundice, if present, by anastomosing the gall-bladder to the jejunum.

Dilatation of the Duodenum (Wilkie's Disease). It is not uncommon to find people, usually adult women with visceroptosis, with somewhat vague dyspeptic symptoms not directly resembling a gastric or duodenal ulcer, in whom on performing a laparotomy very marked dilatation of the first and second parts of the duodenum is present. The symptoms usually date back to childhood and consist of epigastric pain, vomiting, loss of appetite and headache. In some cases no cause for this is apparent, but in others it appears to be due to a definite partial obstruction of the duodenum, produced at the point where the superior mesenteric artery crosses it by the pressure or drag of this vessel. In the cases where no definite obstruction is apparent, the probable cause is some failure of the neuromuscular apparatus. It may possibly be a chronic variety of acute dilatation of the stomach. In these cases the best treatment is the performance of a lateral anastomosis between the second part of the duodenum and a neighbouring high-up coil of jejunum (duodenojejunostomy). This usually will relieve the symptoms.

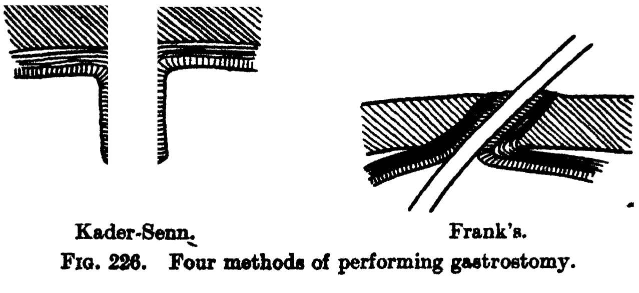
OPERATIONS UPON THE STOMACH

It is only possible here to give the main points in certain operations upon the stomach. For fuller details the student must consult books on operative surgery.

(1) **Gastrotomy.** This consists in opening the stomach for removal of foreign



Marwedel's. Witzel's.



Kader-Senn. Frank's.

FIG. 226. Four methods of performing gastrostomy.

bodies, for exploration or for dilating either the pylorus or œsophageal opening. A small incision is made to the left side of the epigastrium, the rectus being either split or drawn aside, the peritoneum opened either transversely or longitudinally and the stomach drawn into the wound at that part where the opening into it is required. The stomach is then carefully packed off and a small opening made in it, while it is carefully held up with two pairs of Chipault's forceps. The necessary procedures are conducted inside it, and the opening is then carefully closed in two layers with continuous catgut sutures, the inner one through and through all layers and the outer one of the Lembert type.

(2) **Gastrostomy.** This consists in the formation of a permanent opening into the stomach for the introduction of food. Such an opening is required in carcinoma or other forms of irremovable obstruction of the œsophagus. The opening must be placed as high in the stomach as possible, and should be of a valvular type so that gastric contents will not escape.

In this operation the abdomen is opened by a small incision high up in the epigastrium and 1½ inches to the left of the midline, the rectus being split. The stomach is brought up into the wound (this may be difficult if the patient has been starved for long and the stomach is contracted), a suitable spot high up in it is selected and the stomach carefully packed off with pads. There are then three methods of proceeding:—

(*a*) *The Kader-Senn Operation.* A small opening is made in the stomach, a No. 12 or No. 14 rubber catheter stitched in with a catgut stitch and the tube and opening invaginated into the stomach by at least three successive purse-string sutures placed ½ inch away from each other. This produces an invagination resembling the inverted cone unspillable ink-pot. The stomach is then fixed to the peritoneal opening with two silk stitches and the abdomen closed. For after-treatment, see below.

(*b*) *Witzel's Gastrostomy.* Here the stomach is opened, the tube inserted and stitched into it, and the last 1½ inches of the tube, just before it enters the stomach, laid along the stomach wall and invaginated by bringing the portions of the gastric wall on either side of the tube together over it with interrupted silk Lembert stitches. The stomach is then stitched up to the peritoneum and the abdomen closed.

Marwedel's operation is a modification of this, in which the tube is caused to run between the mucous membrane and the muscular wall of the stomach for about 2 inches before entering the organ.

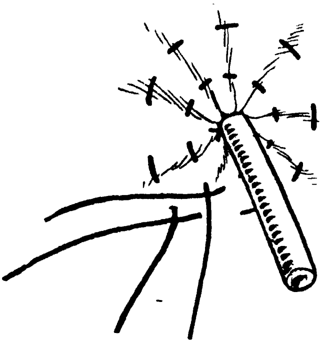


Fig. 227. Method of fixing the tube in the Kader-Senn gastrostomy. (Inverted ink bottle.)

In both these operations the tube remains in until the catgut stitch gives way (about ten days); it is then removed and a gastrostomy plug kept in the opening to prevent its contracting and closing. When a meal is required the plug is removed and the tube introduced. Any food can be given which will pass down a large catheter. Thus soup, milk and eggs, with the addition of brandy, sugar, etc., meat and chicken pounded up and reduced to a semifluid consistency with gravy, etc., can all be introduced. Small meals should be given frequently, *i.e.*, four ounces four-hourly. Benger's food and ovaltine should be avoided, as they are liable to be lumpy and to block the tube. Should this occur, syringe it gently with a solution of sodium bicarbonate.

(*c*) *Frank's Gastrostomy.* In this the incision is made slightly further out and the stomach drawn up into the wound into a cone shape. The peritoneum is sutured all round the stomach about 1½ inches from the apex of this cone. Another small incision, about 1 inch long, is made parallel to and just over the costal margin and about 1½ inches above the previous incision, and the skin and subcutaneous tissues undermined so that the two incisions communicate. The cone of stomach is then drawn under this bridge of skin so that its apex projects through the second wound. A small opening into the stomach is made here, which is then carefully stitched to a portion of the edges of the second incision and the remainder of both incisions are then closed.

This operation is more difficult than the others, and if the stomach is small and contracted may well be impossible. We have found the Kader-Senn method by far the most satisfactory.

(3) **Gastroenterostomy.** This operation is probably both more lauded and more abused than any other operation in surgery, but if only performed where directly indicated its results are good, while the death rate is negligible. The absolute indications are, roughly, for pyloric or duodenal obstruction, simple or malignant, for duodenal ulcer, hourglass stomach, pyloric ulcer and to form part of the operation of gastrectomy. It consists in making a lateral communication between the stomach and the jejunum and may be of many different types. It is described as anterior or posterior, according to whether the opening in the stomach is made in its anterior or posterior wall, as antiperistaltic or isoperistaltic according to whether the stomach and intestine are put together in such a way that the peristaltic waves in the two organs pass in the opposite or the same direction, and as vertical, oblique or horizontal, according to the direction in which the opening in the stomach runs. The posterior operation necessitates bringing the bowel into the lesser sac through

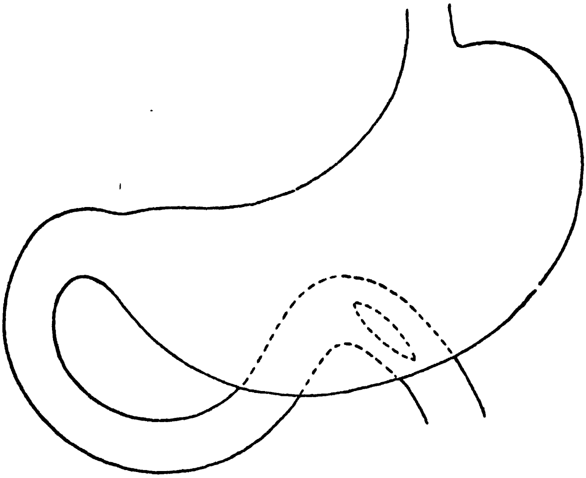


FIG. 228. Diagram of an antiperistaltic gastroenterostomy of the Mayo type.

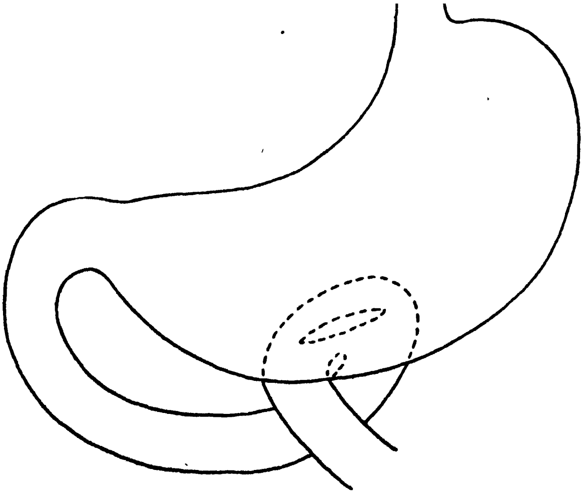


FIG. 229. An isoperistaltic gastroenterostomy.

the transverse mesocolon to reach the posterior wall of the stomach. In the anterior operation the bowel may be brought over and in front of the transverse colon (antecolic anterior gastroenterostomy), or through the transverse mesocolon behind the transverse colon and through the two anterior layers of the great omentum to

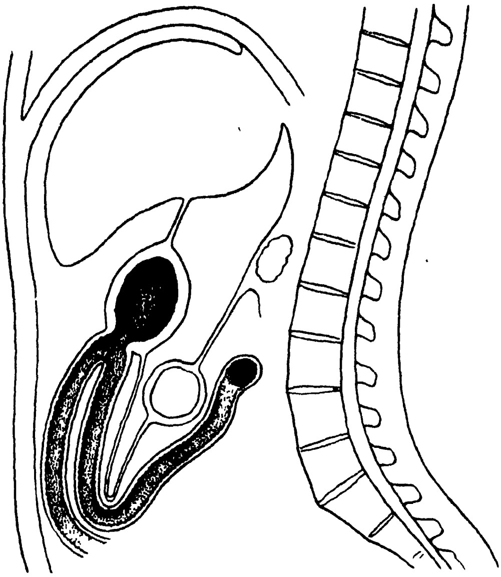


FIG. 230. Anterior antecolic gastroenterostomy with a big loop.

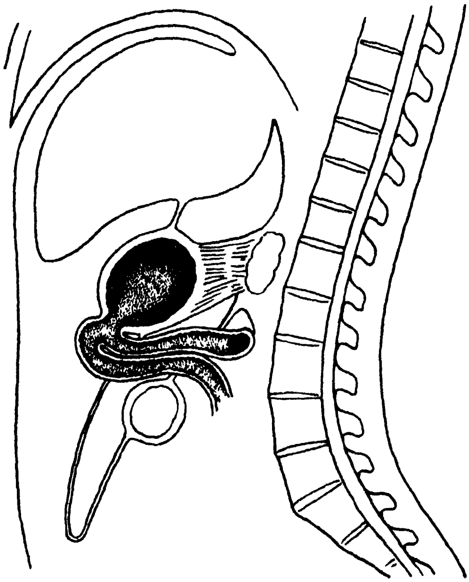


FIG. 231. Anterior retrocolic gastroenterostomy with a loop.

reach the front of the stomach (retrocolic anterior gastroenterostomy). In the posterior operation the opening in the jejunum should be made as near the duodenojejunal flexure as possible (about 3 or 4 inches away from it). This is the "no-loop" operation. In the retrocolic anterior operation this loop needs to be a little longer, but not much. In the antecolic anterior operation, however, a loop of some considerable length must be made (about a foot long), between the flexure and the opening in the jejunum.

The abdomen is opened either just to the right or left of the midline in the epigastrium. All the organs are examined and a decision made as to what procedure should be adopted. The operation of choice is undoubtedly the posterior, "no-loop," isoperistaltic, oblique gastroenterostomy if this is practicable, the opening being at least 2½ or 3 inches long and as near both the greater curvature and the pylorus as possible.

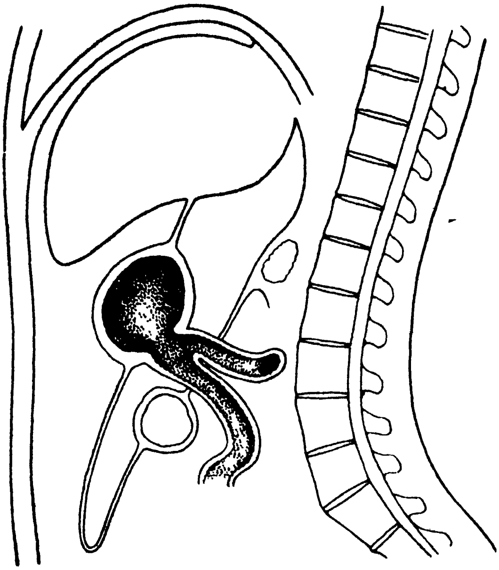


FIG. 232. Posterior no-loop gastroenterostomy.

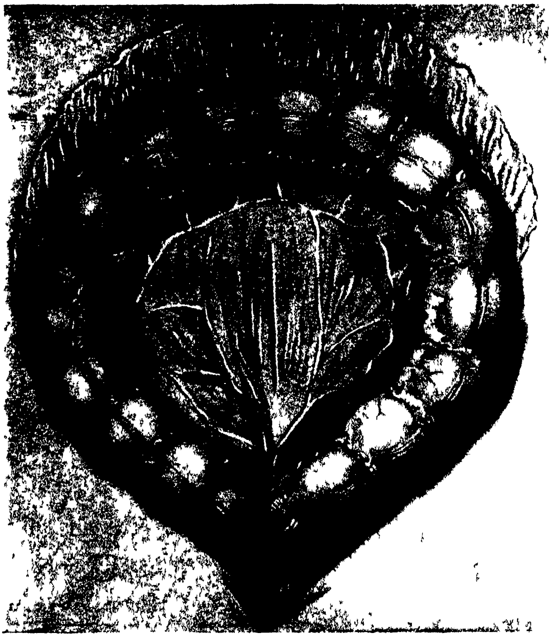


FIG. 233. The opening in the transverse mesocolon for a gastroenterostomy.

(*a*) *The Posterior Operation.* The transverse colon is lifted up to expose the mesocolon; a large opening is made in the mesocolon at a bloodless spot and the posterior wall of the stomach pushed through this, brought up as near the surface as possible, and gripped in a large clamp. The top of the jejunum is then found by drawing up the transverse colon and noting the ligament of Treitz, which descends from the under surface of the mesocolon to the top inch of the jejunum. A corresponding portion of the jejunum is then gripped in another clamp and an isoperistaltic anastomosis performed. The stitching and packing off with pads is done in exactly the same way as in lateral intestinal anastomosis (Figs. 235–239). In the case of gastroenterostomy it is advisable to use two catgut sutures and no silk, as this possibly may diminish the liability to secondary ulceration. If it is preferred to use one layer of silk and one of catgut, the inner layer should be the silk one, as this layer soon will pass into the bowel and be carried away. It is wise not to excise any of the mucous membrane either of the stomach or the bowel, and it is essential to use continuous sutures in order to control the hæmorrhage. A few surgeons prefer not to use clamps,

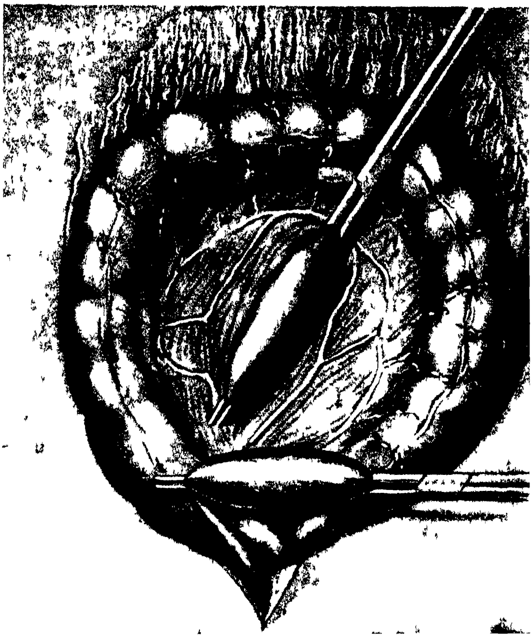


FIG. 234. Stomach pulled through the opening in the mesocolon and clamped. Jejunum also clamped.

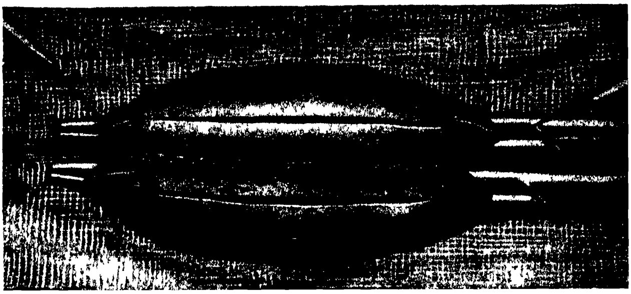


FIG. 235. Performance of a gastroenterostomy. Posterior layer of Lembert sutures inserted.

as they think that by bruising the structures these may predispose to the formation of secondary ulcers, and fear there may be hæmorrhage after the clamps are removed. In any case the clamps had better be removed before the final anterior Lembert inverting layer is introduced. We personally prefer to use clamps of the straight Doyen type, and without rubber guards. Before closing the abdomen the opening in the transverse mesocolon must be closed carefully around the anastomosis by a few interrupted sutures, as otherwise there is some danger of coils of small intestine passing through this aperture and becoming strangulated. The abdomen is then closed in the ordinary manner.

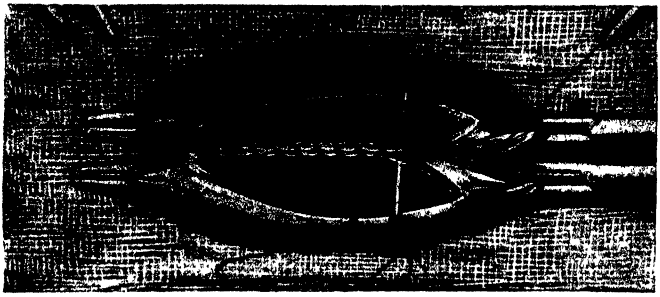


FIG. 236. Gastroenterostomy. Posterior layer of inner or through-and-through sutures inserted.

(*b*) *The Anterior Operation.* Until a few years ago this operation had fallen somewhat into disrepute, as it was thought to be more liable to cause regurgitant vomiting (see p. 647), secondary ulceration, or constriction of the transverse colon. Of recent years, however, the operation has been coming back into fashion to some extent, and many cases will be encountered where, because of adhesions in the lesser sac, or from the situation and size of a growth, the anterior operation alone is possible. In these cases there need be no hesitation in performing it. Some surgeons advise that in this operation, and, indeed, in any gastroenterostomy in which it is necessary to make a fairly long loop of intestine, the liability to regurgitant or vicious vomiting will be decreased if the operation is completed by making a lateral anastomosis between the ascending and descending loops a few inches above and below the opening in the stomach.

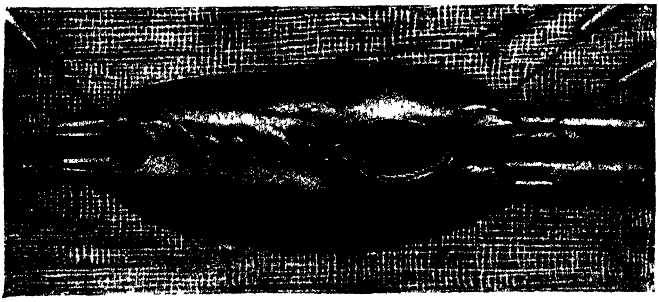


FIG. 237. Gastroenterostomy. Anterior layer of inner or through-and-through stitches nearly completed.

(*c*) *Roux's Gastroenterostomy en Y.* This is an old-fashioned operation, seldom performed now because of its liability to give rise to secondary ulceration. The operation commences as an ordinary posterior gastroenterostomy, but, instead of making a lateral anastomosis between the jejunum and stomach, the jejunum is cut across, its lower end is implanted in the opening at the back of the stomach by end-to-side union, and the upper end of the jejunum is implanted also by end-to-side union in the side of the lower end 3 or 4 inches below the stomach.

After-treatment. This consists in keeping the patient in the Fowler position; one or two small doses of morphia should be given if necessary. In the first twenty-four hours the patient may sip an ounce of water an hour; rectal salines should be given if necessary. In the second twenty-four hours he should have rather larger quantities of water, tea and soup, etc. Milk is best avoided, as it may cause septic clots on the suture line. The third day a little jelly, thin bread and butter, and fish boiled or pounded up to a cream may be added. At the end of a week he may have advanced to minced chicken, minced meat and soft vegetables, and then gradually return to a full diet. We believe that nothing is gained by starving these patients by the mouth for the first two days, as if the surgeon is not confident that his anastomosis is watertight he had better not perform it. Aperients are better avoided for the first week, but enemata should be given if required.

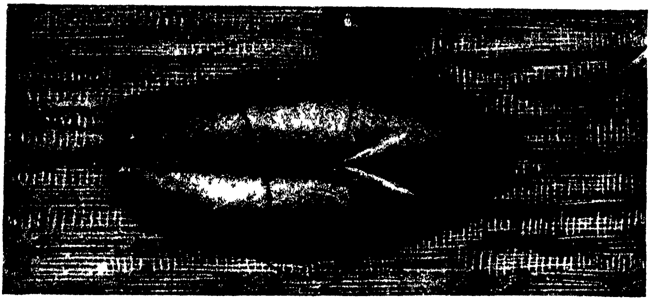


FIG. 238. Gastroenterostomy. Anterior layer of inverting Lembert sutures nearly completed.

For at least six months after the operation he should eat a careful diet and take an alkaline bismuth mixture.

Certain complications may occur after the operation. *Hæmorrhage* into the stomach is occasionally seen and may be profuse. There is profuse hæmatemesis, with marked pallor and rapidity of the pulse. It is often uncertain whether this comes from the suture line or from the ulcer, but it is probably from the latter. This should be treated on medical lines with morphia, ice, adrenalin by the mouth, etc., and nearly always will stop. A second operation is very rarely advisable, and washing out of the stomach is absolutely contra-indicated.

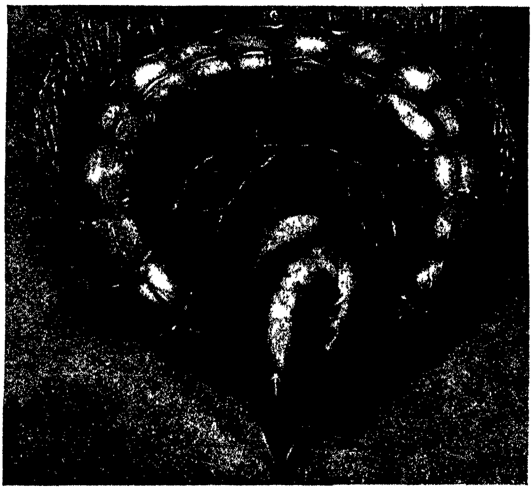


FIG. 239. Gastroenterostomy completed. The aperture in the transverse mesocolon has been sutured to the stomach.

Regurgitant vomiting is a serious complication, which, though formerly common when a long loop operation was performed, is practically never seen nowadays. It consists in the onset, usually after five or six days, of nausea and vomiting of large quantities of bile-stained fluid, and if this persists unchecked the patient will become weak, emaciated, and may die, it must be differentiated from the vomiting seen on the second day due to œdema of the stoma. Should it occur the stomach should be washed out and the patient placed in various positions; sitting him bolt upright or laying him flat upon his face often will effect marked improvement. If simple measures of this kind do not cure it, it is probable that some form of obstruction or kinking at or near the anastomosis is present. In any case the vomiting is in no sense the result of bile entering the stomach. If these measures fail a second operation may become urgently necessary, and this should consist in reopening the abdomen and quickly performing a lateral short circuit between the afferent and efferent loops. This nearly always will cure the condition.

Causes of Failure after Gastroenterostomy. Cases of failure or recurrence of symptoms after a gastroenterostomy are frequently due to its having been performed in unsuitable cases, especially patients with a very high acidity. Thus there can be no justification in performing it for visceroptosis, functional dyspepsia, right-sided pain of uncertain origin, ulcers near the œsophageal opening, etc. In many cases a strict course of medical and dietetic treatment should follow the operation if good results are to be obtained. In all cases an alkaline and bismuth mixture should be persisted in for some months and the teeth be seen to carefully. In other instances an ulcer refuses to heal after the operation, or heals and as a result of indiscretions on the part of the patient becomes active again. A secondary jejunal or gastro-jejunal ulceration may occur (see p. 620). The stoma may not have been made sufficiently large or may become contracted as the result of scarring, while in some cases adhesions will account for persistence of symptoms. Retrograde intussusception of the jejunum into the stomach through the opening has been described both in an acute and a chronic form, occurring even many years after the operation. This gives rise to an ill-defined palpable mobile swelling with griping cramp-like pain, vomiting and visible peristalsis passing from right to left. It requires further operation to put it right, and the prognosis is very bad.

Persistence of pain and discomfort is sometimes attributable to there being too large an opening, so that the food enters the jejunum too rapidly.

(4) **Gastromyotomy.** This is an unusual procedure for gastric ulcer, and consists in making a complete section of both the longitudinal and circular muscle coats down to the mucous membrane around the ulcer and an inch or two away from it. In some cases it may be only possible to make this section for half or two-thirds of a circle around the ulcer. The stomach is exposed and an incision of the shape and size required is made on the stomach wall through the peritoneum only. The peritoneum is then dissected up for the length of this incision for a ¼ inch in the form of a small flap. The circular and longitudinal muscle coats are then divided just to one side of the incision in the peritoneal coat, and the peritoneal coat is then resutured in such a way that this small peritoneal flap is forced down between the divided muscular coats to try and prevent their uniting again. The operation is easy and of negligible mortality. Its results are uncertain, but some satisfactory cases have been seen.

(5) **Partial Gastrectomy.** This operation is performed chiefly for carcinoma of the stomach, but there is now a large school of surgeons who advocate its performance also in nearly every case of gastric ulcer. It has almost entirely taken the place of the older pylorectomy.

(*a*) When performed for malignant disease the operation consists in the removal of the pylorus, the whole of the lesser curvature almost up to the œsophagus, the corresponding half of the greater curvature, the right-hand half of the great omentum, the whole of the lesser omentum, and the glands and lymphatics in the neighbourhood of the cœliac axis artery, these structures all being removed in one piece, as shown in the diagram on p. 633. The line across which the stomach is sectioned is known as Von Mickulicz' line. A right paramedian incision is made, a careful examination of the abdomen is performed to ascertain whether the growth is operable or not, the growth is separated and the coronary artery and the lesser and greater omenta ligatured and cut across. The pylorus and first part of the duodenum are freed; care must be taken in doing this not to damage the pancreas or bile-duct. Clamps are applied at the junction of the pylorus and duodenum and the bowel cut across at this point; the duodenal end is then closed and invaginated (unless Billroth's first method is used, see p. 649), this manœuvre being performed very easily by means of a Parker-Kerr clamp. Half an inch of the duodenum should be removed. The stomach is then turned over to the left, the lesser and greater omenta set free, care being taken not to damage the blood supply to the transverse colon. Two large clamps are placed across the stomach along the second line of section indicated in the diagram, the stomach is cut across and its right-hand half removed. The continuity of the digestive canal may then be restored in several ways.

(1) *Billroth's First Method.* The duodenum is mobilised and its end brought across to the left, the stitch which closed this end temporarily being removed. The long incision across the fundus of the stomach is then closed almost completely with two layers of catgut stitches with the exception of about an inch at its lower end, and into this open inch the open end of the duodenum is implanted and sutured. This is not a satisfactory method as the suturing is difficult and liable to leak, and a raw area is left by the mobilisation of the duodenum.

(2) *Billroth's Second Method.* In this the open end of the duodenum and the open end of the stomach are both completely and permanently closed, and a separate posterior gastroenterostomy is then done into the remaining fundic portion of the stomach. This has the great advantage that the operation if necessary can be done in two stages, the gastroenterostomy being done first and the growth being removed ten days or a fortnight later.

(3) *Kocher's Method.* In this the open end of the stomach is completely closed, the duodenum is mobilised, the stitch in its end cut out and its opened end implanted into the lower part of the back of the remainder of the stomach through a separate incision and sutured there.

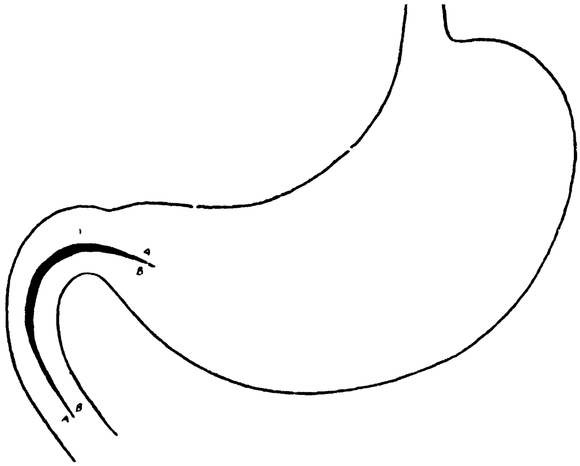


FIG. 240. The incision made in the stomach and duodenum in Finney's pyloroplasty.

(4) *Polya's Method.* This is the method most commonly employed. The end of the duodenum is closed permanently and a coil of jejunum as near as possible to the duodenojejunal flexure is selected and brought up into contact with the open end of the stomach. This may be brought up either in front of the transverse colon or, better, through an opening in the mesocolon. The jejunum is then joined to the open end of the stomach with two layers of sutures, this really constituting an end-to-side anastomosis between the end of the stomach and the side of the jejunum.

Mayo's modification of this operation consists in making the incision in the jejunum only long enough to correspond to the upper half of the open end of the stomach. The suturing is then done in such a way that the lower half of the open end of the stomach is closed at the same time that it is attached to the jejunum.

(5) Other methods of performing gastrectomy are Schoemaker's, Finsterer's and Pauchet's.

(b) In the case of a simple ulcer a similar operation may be performed. It is not, however, necessary to remove so much of the stomach, lesser omentum or greater omentum, and the lymphatic drainage area need not be removed.

This operation is more severe than a gastroenterostomy and has a somewhat greater mortality. Its immediate results are excellent, and it is most unlikely to be followed by secondary ulceration. The after-treatment is the same as that of gastroenterostomy (see p. 646). Very few cases of carcinoma of the stomach removed by gastrectomy live three years.

Limited forms of gastrectomy are occasionally performed. Thus a small ulcer may be excised locally, a saddle-shaped ulcer on the lesser curvature may be removed by means of an extensive saddle-shaped excision, and an annular or sleeve resection of the central portion of the stomach with end-to-end union may be performed for hourglass stomach. All these operations should be followed by a gastroenterostomy. Their results are not good, and nowadays they have been almost entirely replaced by gastrectomy.

Balfour's operation is useful for ulcers very near the œsophagus. In this the ulcer is burnt out with a cautery, the opening in the stomach is sutured in two layers and a gastroenterostomy performed.

Total gastrectomy has been performed occasionally for malignant disease and leather-bottle stomach. The end of the œsophagus is then anastomosed to the jejunum. The operation is difficult, and for its technique the student is referred to books on operative surgery.

(6) **Rammstedt's operation** for congenital hypertrophic pyloric stenosis. This is described on p. 629.

(7) **Pyloroplasty.** A series of operations have been described for increasing the lumen of the pylorus when it is strictured. One of these consists in incising the pylorus longitudinally and suturing it transversely with two layers of sutures. Cases suitable for this operation are, however, very few and far between, as it is impossible if any marked degree of infiltration of the tissues is present, and the presence of scar tissue usually renders it unwise. If any operation of this kind upon the pylorus is advisable the best is undoubtedly the following.

(8) **Finney's Operation (Gastroduodenostomy).** This may be regarded as one form of pyloroplasty, and is sometimes employed as an alternative form of gastroenterostomy. The anastomosis is made between the pyloric end of the stomach and the neighbouring portion of the duodenum ; it is not essential to use clamps, but if preferred the duodenum and stomach are engaged in clamps, these being placed as close together as possible. The clamps are then twisted round to bring their contents into contact, this producing a sharp angulation at the junction of the stomach and duodenum. Instead of making two separate incisions in the stomach and bowel, as in a gastroenterostomy, one continuous incision is made running along the middle of that portion of the stomach engaged in one clamp, and turning round and coming back along the middle of the portion of the duodenum engaged in the other clamp. The suturing is then performed in a manner similar to a gastroenterostomy. The presence of scar tissue and infiltration precludes the performance of this operation, and there are, therefore, not many cases suitable for it. It presents no great advantage over a gastroenterostomy and is considerably more difficult, but its results are usually very good.

(9) **Cholecystogastrostomy.** This consists in making a lateral anastomosis between the fundus of the gall-bladder and the stomach. The gall-bladder is first emptied, and a lateral union is made between it and the pyloric part of the stomach, the suturing being done exactly as in a gastroenterostomy. Only a small opening about an inch long need be made (see p. 763).

CHAPTER XVI

DISEASES OF THE INTESTINES. INTESTINAL OBSTRUCTION

Surgical Anatomy. The surgical anatomy of the intestinal tract is intimately connected with that of the peritoneum, pelvis and other abdominal organs, which is described on p. 504, etc. For purposes of description, we are here dealing only with that portion of the bowel which extends from the duodenojejunal flexure to the top of the rectum; the other portions are described in Chapters XV. and XIX. So intimately is the intestine related to the peritoneum at all parts that diseases of one structure are particularly liable to involve and affect the other. It must be remembered that the coils of the small intestine have no fixed position and are overlapped by the greater omentum to a varying degree. The only method, therefore, of identifying the position of a particular coil is by tracing the remainder of the bowel up to the duodenum or down to the cæcum ; the upper end of any coil, however, may be identified by holding the coil up and passing the hand down to the root of its mesentery, when the direction in which the mesenteric root is running when the mesentery is untwisted will show which is the upper and which is the lower end. Though it is impossible to say where the jejunum ends and the ileum begins, there is, nevertheless, a marked difference between the higher jejunal and the lower ileal coils, the jejunal coils having a larger diameter, a thicker and more vascular wall, a darker colour, a thicker mesentery, and the lacteals more marked after a meal. The ileal coils are further distinguished by the presence of numerous Peyer's patches.

The whole of the small intestine has a mesentery, this consisting of a double fat-containing peritoneal fold, fastening the intestine back to the posterior abdominal wall in a line extending from just to the left of the body of the second lumbar vertebra to the right iliac fossa. The mesentery has many important functions in addition to fixing the bowel. It contains many lymphatic glands liable to be involved by cancer and infections, whilst the greatest care must be taken not to damage it when performing a laparotomy, as it is very vascular and provides the complete blood supply of the intestine ; it is also freely supplied with nerves which are wholly derived from the solar plexus, so that damage to this structure by trauma or disease is productive of marked shock. It will be seen that the mesentery, with its line of attachment, divides the peritoneal cavity into two compartments, a right upper one and a left lower one.

Certain parts of the large intestine are fixed and constant in position, owing to the absence of a mesentery ; the most constantly fixed parts are the splenic flexure and descending colon. The cæcum and hepatic flexure, though normally without a mesentery, are, nevertheless, frequently provided with this structure, and may then be found in unexpected situations. The transverse colon has a long mesentery and is freely movable ; its position is uncertain, as it may descend even as low as the pelvis. The transverse mesocolon is attached across the posterior abdominal wall, and as a shelf divides the abdomen into an upper and lower part. The pelvic colon also has a well-marked mesentery, and though its upper and lower ends are more or less fixed in position, its large S-shaped coil may be found almost anywhere in the pelvis, or even the upper parts of the abdomen. The large intestine can be distinguished from the small intestine at a glance by its sacculation, its longitudinal bands, and its appendices epiploicæ.

Although the greater part of the absorption of the nutriment occurs in the small intestine, it is remarkable how much of this can be removed surgically without malnutrition occurring. There are several cases in which 12 and 15 feet have been removed without evil effect. The contents of the small intestine are completely fluid, and may be expected to commence to reach the colon in normal individuals in from three to four hours. In the cæcum and right side of the colon absorption of water occurs, and the contents become semisolid, and in this portion of the bowel certain antiperistaltic waves occur which tend to delay the food and promote absorption, the ileocæcal valve preventing regurgitation into the ileum. By means of these antiperistaltic waves material can be transferred from the left side of the colon back to the right side, and this is a point which must be considered seriously in connection with the surgical removal of certain parts of the colon ; it also accounts for the way in which rectal salines may pass up to the cæcum, and for the very marked distension of the cæcum which occurs in complete or partial obstruction of the colon. The time taken for food matter to traverse the colon varies enormously ; nothing is likely to reach the splenic flexure under seven or eight hours. In the left side of the colon the contents are solid, becoming more and more so as the lower parts of the bowel are reached. The pelvic colon acts as a reservoir for the fæcal matter which accumulates there before expulsion.

The infectivity and bacterial contents of the intestine increase rapidly from its upper to its lower end, the contents of the colon being specially infective. Streptococci, staphylococci, B. welchii and the organisms of the B. coli group predominate, while the presence of intestinal obstruction rapidly increases the number and virulence of these bacteria. While the intestinal wall is healthy there is very little likelihood of organisms passing through it ; but if the wall is damaged as the result of obstruction, injury, congestion, or interference with its blood supply, organisms will freely pass through it and invade the peritoneum.

Methods of Examination. In diseases of the intestine the usual methods of abdominal examination must be employed, such as inspection, palpation, and percussion. Auscultation in diseases of the intestine and peritoneum is also of the greatest value as showing whether peristalsis is present, absent, increased or diminished. Much information also can be obtained by examination of the rectum and vagina. In addition to these methods, other information can be obtained by a naked-eye, bacteriological and chemical examination of the fæces, the most important abnormal characteristics likely to be observed by the naked eye being the presence of mucus, blood, which may be either bright or dark and tarry or may require chemical examination for its detection, and pus. In addition to this, the colour, shape and consistence of the motions should be examined.

The X-ray examination of the intestinal canal by means of a bismuth or *barium meal* is of very great importance, though its results are perhaps not as reliable as in the case of the stomach and duodenum (see p. 610). The times taken for the meal to reach the various points are roughly as follows : the stomach should be quite empty in four hours, and the meal should begin to reach the cæcum in about four hours, the hepatic flexure in six to eight hours, the splenic flexure in twelve to fourteen hours, and the iliac colon in about sixteen hours. It should all have disappeared in about twenty-four to thirty-six hours. The appendix sometimes can be demonstrated by this means. In the colon, and especially the lower part of it, valuable information will be obtained by means of a bismuth or *barium enema.* Strictures, kinks and diverticula may be demonstrated by this means.

The *sigmoidoscope* is a valuable instrument, by means of which the inside of the rectum and the whole of the pelvic colon can be seen and examined. The examination can be made without an anæsthetic, though it is by no means comfortable. A portion of an ulcer, growth, etc., by means of it may be removed for microscopy. To perform this examination the bowel must be emptied thoroughly by means of two enemata ; the patient is placed on his left side near the edge of the table with his knees drawn well up and the pelvis on a pillow. On no account must the tube be pushed forwards without the bowel being distended by air all the time, while it is well not to stretch the sphincter before introducing the instrument, as if this is done the air will escape at the side of the tube.

Surface Markings. There are very few surface markings in connection with the intestine, owing to its mobility, the only two of any importance being that for the ileocæcal valve, which is at the junction of the right lateral and intertubercular planes, and the opening of the appendix, which is an inch below this point. Neither of these two points has anything to do with McBurney's point, which is a purely clinical observation (see p. 709).

Development. The development of the gut has a bearing upon certain congenital conditions. The primitive gut communicates with the yolk sac by means of the Vitelline duct, and later becomes differentiated into a foregut, which ultimately gives rise to the œsophagus, stomach and duodenum as far as the papilla of Vater, a midgut from which is developed the whole of the intestinal canal from there down to about the middle of the pelvic colon, and a hindgut, from which the remainder of the pelvic colon and the rectum are formed. The Vitelline duct communicates with the midgut. By degrees the small and large intestine are developed and differentiated, and a rotation of the whole gut towards the right occurs, which accounts for the transverse colon crossing the duodenum. The cæcum at first lies high up, just below the liver, and only later descends to the right iliac fossa. In this way the presence of a mobile cæcum, and of the cæcum and appendix high up under the liver, which are occasionally seen, may be accounted for.

Congenital Intestinal Conditions. Stenosis of the pylorus and duodenum and diverticula in this neighbourhood have already been described (pp. 626, 636). Congenital strictures and septa giving rise to more or less definite obstruction are occasionally seen elsewhere in the bowel, especially at the hepatic and splenic flexures.

Multiple congenital diverticula are very rarely seen in the small bowel protruding through the muscular wall into the root of the mesentery. They do not often give rise to symptoms unless infection supervenes. The diverticula of the colon are not congenital (see p. 663).

Meckel's Diverticulum. This is a large diverticular outgrowth which is occasionally seen to protrude from the anti-mesenteric border of the ileum about 2 or 3 feet from the cæcum; its patent part is usually 2 or 3 inches long, and it is said to occur in about 2 or 3 per cent. of people. It frequently terminates in a fibrous cord, which may run up to the umbilicus, may lie freely among the intestines, or contract secondary adhesions elsewhere. Occasionally the diverticulum persists patent as far up as the umbilicus, where there is a congenital fistula (see p. 528). This condition is due to persistence of the intestinal portion of the Vitelline duct (omphalomesenteric duct). The structure of the patent portion is that of the ileum in general, while occasionally a little pancreatic tissue is found in its wall. The diverticulum usually will be found to be lying on the right-hand side of the abdomen. When present in a hernia the condition is known as Littré's hernia.

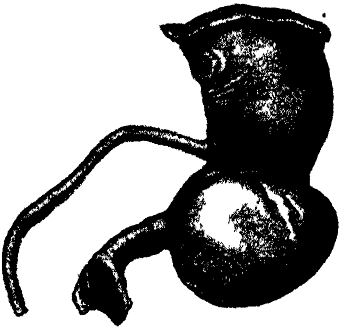


FIG. 241. Meckel's diverticulum with a band attached to it which had snared the bowel.

The Vitelline duct normally passes from the intestine to the umbilicus, and should be obliterated about the eighth week of intrauterine life, this obliteration spreading inwards towards the bowel. All forms of partial obliteration are found, ranging from complete patency to a mere fibrous cord; occasionally the central portion remains open, while the ends close, and this gives rise to an intra-abdominal cyst. The tubular portion of the diverticulum usually has a small mesentery running up towards the umbilicus, or attached to the bowel mesentery close by.

It is impossible to diagnose the presence of a Meckel's diverticulum until complications arise but the presence of an umbilical polyp, colic with retraction of the umbilicus, or attacks of bleeding from the rectum in a child when no obvious cause can be detected are all suspicious signs that a Meckel's diverticulum is present, while a barium meal and X-ray picture will occasionally demonstrate the presence of a patent diverticulum. These complications are not infrequent, and may be very serious.

Complications.

(*a*) *Acute Inflammation.* Acute inflammation of varying grades of severity may occur in a Meckel's diverticulum, which in its turn leads to complications similar to those which follow acute appendicitis; thus catarrhal inflammation, gangrene and perforation, the latter leading either to a local abscess or more commonly to general peritonitis, all occur. As the diverticulum usually lies in the right iliac fossa the resemblance to acute appendicitis is so close that the diagnosis is almost impossible, unless the patient has had his appendix removed previously, while owing to the absence of adhesions and the large lumen of the diverticulum, perforations are very serious. The treatment consists in operation performed as soon as possible; the diverticulum should be removed and the opening into the bowel sutured and inverted. As the peritonitis set up by a perforated Meckel's diverticulum will cause reddening of the vermiform appendix, the inexperienced surgeon must beware in such a case of removing the reddened appendix as the cause of the disease and leaving behind the perforated Meckel's diverticulum.

(*b*) In common with other lesions of the small intestine, such as polyps, sarcomata, etc., the diverticulum may be the cause and form the apex of an *intussusception* (see p. 691). Such an intussusception usually occurs in older children between the ages of three and twelve, and is generally of the enteric type.

(*c*) The occurrence of a Meckel's diverticulum in a hernia is known as a *Littré's hernia* (see p. 563).

(*d*) Not uncommonly this relic gives rise to a very acute form of *intestinal obstruction* by snaring or strangulating the bowel, whether its distal end is free or attached to the anterior abdominal wall. In other instances the diverticulum, by dragging on the bowel or by its mere weight when distended, may twist the bowel and cause a *volvulus*. In all these instances urgent operation will have to be performed, and when the obstruction has been relieved the diverticulum should be removed (see p. 683).

(*e*) It sometimes happens that a slow form of ulceration occurs at the site where the diverticulum joins the main bowel, and in the process of healing of this ulceration the formation of scar tissue will lead ultimately to a *fibrous stricture* of the bowel at that point. In this connection several observers have found islets of gastric mucosa and of pancreatic tissue in the wall; these may give rise to acute or chronic ulceration analogous to peptic ulcer in the stomach and liable to cause abdominal pain and indigestion, while occasionally they may perforate or bleed and cause melæna. The appropriate treatment is described on p. 668.

(*f*) Melæna may be caused by a Meckel's diverticulum as a result of ulceration, trauma from irregular peristalsis, acute inflammation, infarction and the presence of a new growth.

Whenever encountered, whether complications are present or not, Meckel's diverticulum should be removed, as it is a source of grave danger.

of the Colon).

impulses. No organic obstruction is usually visible, but in some cases a band of fibrous tissue, which possibly causes intermittent obstruction, is found running across the back of the lower part of the rectum or at the pelvirectal junction. In other instances it may be that, as a result of the distension of the pelvic colon with meconium at birth, and also of constipation later on, the pelvic colon sags down and forms a fold, which kinks the upper part of the rectum and finally causes a more or less valvular obstruction here. Should the pelvic colon rise up into the abdomen again, the obstruction may be temporarily relieved. The more the hypertrophy, the less marked the obstructive and other symptoms are, and the better the chances of the child reaching adult life. Spasm at the pelvirectal junction may cause some cases, while come form of neuro-muscular inco-ordination must play a part in others, and the probability is that many cases are due to a relative paralysis of vagal impulses to the sphincter, a condition comparable to achalasia and pylorospasm (see Vol. I., Ch. XII.).

Clinical Features. The condition usually commences in the first year of life, and is more common in boys, in whom it gives rise to obstinate and steadily increasing constipation. Purgatives have little effect and only cause pain and sickness, and the bowels may not be opened for weeks, though prolonged periods of relief occur. An enema is often retained, but occasionally acts and produces a small action, while the flatus tube will bring away much foul gas; should a motion be passed it is particularly offensive. After a short time abdominal distension sets in and may become enormous, deforming and pushing outwards the lower ribs; vomiting is rare, the abdomen is soft, and there is little pain; visible peristalsis and borborygmi are marked. Hard scybalous masses may be felt in the abdomen or P.R. Emaciation and toxæmia will be present to varying degrees, and œdema of the legs, albuminuria and tetany occur at times; in most cases death occurs during childhood from toxæmia, perforation or interference with the heart's action. On the other hand, when hypertrophy is marked, adult life may be reached, though the symptoms will persist. In this case, after middle age, it is highly probable that the bowel again will become toneless, the symptoms worse, and the patient succumb. X-ray films are of little value beyond showing the distension of the colon.

Treatment. Enemata and colon washouts, electrical treatment and abdominal massage are all valuable, but purgatives should be avoided if possible as they do more harm than good. In most cases these measures ultimately fail and then surgical treatment should be undertaken before the condition becomes too bad. Recently many cases have been treated by lumbar ramisection or section of the presacral nerve in order to get rid of its inhibiting effect on the sphincter; this has had a fair measure of success. In the rare cases where a band can be felt at the back of the rectum, this should be divided by open operation from behind (linear proctotomy), and in other instances the best treatment is excision of the distended portion of the colon. This is a dangerous operation, but its risk can be diminished considerably by draining the bowel first by a cæcostomy or colostomy, and the operation may be performed in two stages by creating the anastomosis first. It is often noticed after a colostomy that an enema will pass much more freely up to the colostomy from the rectum than down through the rectum from the colostomy.

Visceroptosis (Glenard's Disease). This is a condition most commonly seen in women in which the greater part of the abdominal viscera are prolapsed and have descended to a lower level than normal. The cause of the condition

[redacted]

cæcum is valueless; resection of the cæcum and ascending colon is occasionally valuable in those cases where the distension and stasis are especially marked; it is, however, a serious operation. We are entirely opposed to such procedures as gastroenterostomy, ileosigmoidostomy or resection of the whole colon for this condition.

Injuries of the Intestine (*Contusions, Wounds and Rupture*). These are described in Chapter XIII

Foreign Bodies in the Intestine. Foreign bodies are not commonly met with in the intestine, as if they pass through the pylorus they probably will traverse the whole intestinal length and emerge at the anus. It must be remembered that though the majority of such foreign bodies enter the intestine from the stomach, a few find their way into it from the rectum. Elongated or heavy bodies will become impacted occasionally in the second part of the duodenum, and the only other point at which impaction is likely to occur is the neighbourhood of the ileocæcal valve. Foreign bodies accidentally or purposely swallowed are usually seen either in children or lunatics and may be of enormous variety.

In addition to those swallowed, enteroliths are occasionally formed in situ. These are especially liable to form when there has been intestinal catarrh, or in those who eat coarse oatmeal, or in patients who have been taking insoluble salts as medicine, such as magnesium, bismuth or calcium carbonate. They usually consist either of these salts, or else of phosphates of magnesium and lime, or carbonate of lime and ammonia around a central organic nucleus. In some instances they consist of inspissated fæces mingled together with indigestible vegetable fibre, hair or cocoanut fibre, the nucleus often consisting of a fruit stone. These bodies are particularly common in horses. They are stony hard and may become very large, generally tending to increase in size. Occasionally they are found to lie in a diverticulum of the bowel wall and may pass suddenly from there into the bowel lumen.

In most instances they give rise to very little in the way of symptoms until one of the two common complications sets in, namely, either impaction, in which case the signs and symptoms of acute obstruction supervene (see p. 689), or perforation of the bowel wall (see p. 660). A perforation of this kind sometimes occurs gradually, the actual site being protected by previously formed adhesions; so that at times it will give rise merely to a local abscess and not to general peritonitis. On the local abscess bursting or being opened the foreign body sometimes will be extruded.

When neither of these complications is present the condition will give rise sometimes to colicky pain and diarrhœa. Melæna may be present if ulceration of the bowel wall has occurred, and before the final inflammation, gangrene and perforation, the latter leading either to a local abscess or more commonly to general peritonitis, all occur. As the diverticulum usually lies in the right iliac fossa the resemblance to acute appendicitis is so close that the diagnosis is almost impossible, unless the patient has had his appendix removed previously, while owing to the absence of adhesions and the large lumen of the diverticulum, perforations are very serious. The treatment consists in operation performed as soon as possible; the diverticulum should be removed and the opening into the bowel sutured and inverted. As the peritonitis set up by a perforated Meckel's diverticulum will cause reddening of the vermiform appendix, the inexperienced surgeon must beware in such a case of removing the reddened appendix as the cause of the disease and leaving behind the perforated Meckel's diverticulum.

(*b*) In common with other lesions of the small intestine, such as polyps, sarcomata, etc., the diverticulum may be the cause and form the apex of an *intussusception* (see p. 691). Such an intussusception usually occurs in older children between the ages of three and twelve, and is generally of the enteric type.

(*c*) The occurrence of a Meckel's diverticulum in a hernia is known as a *Littré's hernia* (see p. 563).

(*d*) Not uncommonly this relic gives rise to a very acute form of *intestinal obstruction* by snaring or strangulating the bowel, whether its distal end is free or attached to the anterior abdominal wall. In other instances the diverticulum, by dragging on the bowel or by its mere weight when distended, may twist the bowel and cause a *volvulus.* In all these instances urgent operation will have to be performed, and when the obstruction has been relieved the diverticulum should be removed (see p. 683).

(*e*) It sometimes happens that a slow form of ulceration occurs at the site where the diverticulum joins the main bowel, and in the process of healing of this ulceration the formation of scar tissue will lead ultimately to a *fibrous stricture* of the bowel at that point. In this connection several observers have found islets of gastric mucosa and of pancreatic tissue in the wall; these may give rise to acute or chronic ulceration analogous to peptic ulcer in the stomach and liable to cause abdominal pain and indigestion, while occasionally they may perforate or bleed and cause melæna. The appropriate treatment is described on p. 668.

(*f*) Melæna may be caused by a Meckel's diverticulum as a result of ulceration, trauma from irregular peristalsis, acute inflammation, infarction and the presence of a new growth.

Whenever encountered, whether complications are present or not, Meckel's diverticulum should be removed, as it is a source of grave danger.

Hirschsprung's Disease (Congenital Dilatation of the Colon). This is a rare condition, usually met with in young children and occasionally lasting until adolescence. It is more common in males and may date back to birth. The lower half of the colon, especially the sigmoid flexure, is enormously dilated; the rectum shares in the dilatation, but the anal canal is normal. At times it extends right round to the cæcum. In the bowel wall hypertrophy, as well as dilatation, is present, and the colon, which may be 6 or 8 inches in diameter, even in tiny children, appears to fill the whole abdomen, and gives rise to enormous abdominal distension. It loses its sacculation and may have a wall nearly half an inch thick. Sooner or later stercoral ulcers will be present. The wall of the bowel is thickened in varying degrees, owing to hypertrophy of the circular muscle and the formation of fibrous scar tissue, the whole condition probably resulting from disturbance of balance of the sympathetic impulses. No organic obstruction is usually visible, but in some cases a band of fibrous tissue, which possibly causes intermittent obstruction, is found running across the back of the lower part of the rectum or at the pelvirectal junction. In other instances it may be that, as a result of the distension of the pelvic colon with meconium at birth, and also of constipation later on, the pelvic colon sags down and forms a fold, which kinks the upper part of the rectum and finally causes a more or less valvular obstruction here. Should the pelvic colon rise up into the abdomen again, the obstruction may be temporarily relieved. The more the hypertrophy, the less marked the obstructive and other symptoms are, and the better the chances of the child reaching adult life. Spasm at the pelvirectal junction may cause some cases, while come form of neuro-muscular inco-ordination must play a part in others, and the probability is that many cases are due to a relative paralysis of vagal impulses to the sphincter, a condition comparable to achalasia and pylorospasm (see Vol. I., Ch. XII.).

Clinical Features. The condition usually commences in the first year of life, and is more common in boys, in whom it gives rise to obstinate and steadily increasing constipation. Purgatives have little effect and only cause pain and sickness, and the bowels may not be opened for weeks, though prolonged periods of relief occur. An enema is often retained, but occasionally acts and produces a small action, while the flatus tube will bring away much foul gas; should a motion be passed it is particularly offensive. After a short time abdominal distension sets in and may become enormous, deforming and pushing outwards the lower ribs; vomiting is rare, the abdomen is soft, and there is little pain; visible peristalsis and borborygmi are marked. Hard scybalous masses may be felt in the abdomen or P.R. Emaciation and toxæmia will be present to varying degrees, and œdema of the legs, albuminuria and tetany occur at times; in most cases death occurs during childhood from toxæmia, perforation or interference with the heart's action. On the other hand, when hypertrophy is marked, adult life may be reached, though the symptoms will persist. In this case, after middle age, it is highly probable that the bowel again will become toneless, the symptoms worse, and the patient succumb. X-ray films are of little value beyond showing the distension of the colon.

Treatment. Enemata and colon washouts, electrical treatment and abdominal massage are all valuable, but purgatives should be avoided if possible as they do more harm than good. In most cases these measures ultimately fail and then surgical treatment should be undertaken before the condition becomes too bad. Recently many cases have been treated by lumbar ramisection or section of the presacral nerve in order to get rid of its inhibiting effect on the sphincter; this has had a fair measure of success. In the rare cases where a band can be felt at the back of the rectum, this should be divided by open operation from behind (linear proctotomy), and in other instances the best treatment is excision of the distended portion of the colon. This is a dangerous operation, but its risk can be diminished considerably by draining the bowel first by a cæcostomy or colostomy, and the operation may be performed in two stages by creating the anastomosis first. It is often noticed after a colostomy that an enema will pass much more freely up to the colostomy from the rectum than down through the rectum from the colostomy.

Visceroptosis (Glenard's Disease). This is a condition most commonly seen in women in which the greater part of the abdominal viscera are prolapsed and have descended to a lower level than normal. The cause of the condition is uncertain; weakness of the abdominal musculature, yielding of suspensory ligaments, repeated pregnancies or a severe illness and tight-lacing may all play a part in it. In most cases the displacement is general, while in others it seems to be most marked in the stomach (gastroptosis, see p. 628), the liver and spleen, or the kidney (movable kidney, see p. 818), and in many cases the cæcum and ascending colon are chiefly involved (Vol. I., Ch. XII.). In many instances the condition is very marked and yet causes no symptoms, while the symptoms and degree of displacement in no way correspond. Marked neurasthenia is often present, while in other cases vague dragging pains, a sense of weight, tiredness, lassitude and dyspepsia are complained of; constipation and intestinal stasis may be marked. The symptoms are usually relieved by lying down, but more severe cases are occasionally seen where the symptom-complex may closely resemble either—

(*a*) Gastric ulcer;
(*b*) Gall-stones; or
(*c*) Renal colic.

Indeed, the possibility of visceroptosis must always be remembered in every case of chronic abdominal pain; it is a frequent cause of an erroneous diagnosis of chronic appendicitis.

The lower part of the abdomen is unduly protuberant, and both clinical and X-ray evidence can be obtained of the prolapse of the stomach, cæcum, transverse colon, liver and kidneys. The descent of the intestines increases the liability to hernia; the descent of the transverse colon creates a marked tendency to constipation and may drag upon the duodenum and thereby give rise to the duodenal and gastric symptoms, while it may be that the commonly associated neurasthenia is the result of interference with the sympathetic plexuses.

Some authorities have laid great stress upon the symptoms produced in this condition by the mobility, descent and dilatation of the cæcum and ascending colon, this being the only part of the bowel which, in the erect posture to which man is condemned, has to force its contents upwards against gravity. To the dragging of this prolapsed and overloaded viscus upon the mesentery, upon the kidney, upon the gall-bladder and the duodenum and pylorus are attributed many of the diseases to which these organs are liable (*mobile cæcum*), while to the condition itself are ascribed such symptoms as pain, aching and tenderness. The hepatic flexure is often found in this condition to have prolapsed into the right iliac fossa. This condition of mobile cæcum possibly may give rise to severe and acute symptoms of pain and vomiting, which are probably due to partial volvulus or acute kinking of the bowel in that situation.

Treatment. The treatment of this condition is almost entirely medical and is directed partly towards the neurasthenia on general medical lines. The wearing of a proper supporting belt is, however, greatly beneficial, and, in our opinion, by far the most satisfactory one is the Curtis Abdominal Support. The ordinary abdominal belts which encircle the patient's waist sometimes do more harm than good; *they must all be put on while the patient is recumbent.* In most cases an operation is a thing to be avoided and operations to stitch the stomach and liver into place should on no account be countenanced. In certain cases of movable kidney an operation may be beneficial (see p. 818), while in cases where the cæcum and ascending colon are abnormally mobile the operation of colopexy has been greatly lauded by certain enthusiasts. In our experience a few exceptional cases have been improved by it, but in most cases it has proved a failure. Many other operative procedures have been devised. Cæcoplication or infolding of a distended cæcum is valueless; resection of the cæcum and ascending colon is occasionally valuable in those cases where the distension and stasis are especially marked; it is, however, a serious operation. We are entirely opposed to such procedures as gastroenterostomy, ileosigmoidostomy or resection of the whole colon for this condition.

Injuries of the Intestine (*Contusions, Wounds and Rupture*). These are described in Chapter XIII.

Foreign Bodies in the Intestine. Foreign bodies are not commonly met with in the intestine, as if they pass through the pylorus they probably will traverse the whole intestinal length and emerge at the anus. It must be remembered that though the majority of such foreign bodies enter the intestine from the stomach, a few find their way into it from the rectum. Elongated or heavy bodies will become impacted occasionally in the second part of the duodenum, and the only other point at which impaction is likely to occur is the neighbourhood of the ileocæcal valve. Foreign bodies accidentally or purposely swallowed are usually seen either in children or lunatics and may be of enormous variety.

In addition to those swallowed, enteroliths are occasionally formed in situ. These are especially liable to form when there has been intestinal catarrh, or in those who eat coarse oatmeal, or in patients who have been taking insoluble salts as medicine, such as magnesium, bismuth or calcium carbonate. They usually consist either of these salts, or else of phosphates of magnesium and lime, or carbonate of lime and ammonia around a central organic nucleus. In some instances they consist of inspissated fæces mingled together with indigestible vegetable fibre, hair or cocoanut fibre, the nucleus often consisting of a fruit stone. These bodies are particularly common in horses. They are stony hard and may become very large, generally tending to increase in size. Occasionally they are found to lie in a diverticulum of the bowel wall and may pass suddenly from there into the bowel lumen.

In most instances they give rise to very little in the way of symptoms until one of the two common complications sets in, namely, either impaction, in which case the signs and symptoms of acute obstruction supervene (see p. 689), or perforation of the bowel wall (see p. 660). A perforation of this kind sometimes occurs gradually, the actual site being protected by previously formed adhesions; so that at times it will give rise merely to a local abscess and not to general peritonitis. On the local abscess bursting or being opened the foreign body sometimes will be extruded.

When neither of these complications is present the condition will give rise sometimes to colicky pain and diarrhœa. Melæna may be present if ulceration of the bowel wall has occurred, and before the final attack of acute obstruction sets in, minor subacute and transient attacks may arise. In patients with thin abdominal walls the concretion sometimes can be felt, while many are visible in an X-ray film.

In the colon obstruction is less likely to arise, but the foreign body will give rise to colic and frequent loose stools, containing pus, mucus or blood.

Very small foreign bodies, such as pips, pins, pieces of enamel, shot, toothbrush hairs, etc., are occasionally found in the appendix vermiformis or in diverticular pouches of the colon (see p. 663). Here they are liable to be associated with, and possibly to give rise to, acute inflammatory attacks.

The third type of foreign body which is occasionally seen in the intestine is the gall-stone. Small gall-stones which pass down the bile-duct into the bowel, thereby causing biliary colic, give rise to no further symptoms, but large ones will behave as other foreign bodies and may become impacted or give rise to perforation. Stones large enough to do this must have entered the bowel, not via the bile-duct, but by the formation of a direct fistula between the gall-bladder and the duodenum. They also increase in size the longer they remain in the bowel (see also p. 689).

Treatment. In uncomplicated cases, where neither obstruction nor perforation is present, a reasonable time should be given in the hope that the foreign body will pass out through the anus. Should this fail the abdomen must be opened, the coil of bowel be incised, the foreign body removed and the bowel wall sutured transversely in two layers. The treatment of those cases in which obstruction or perforation is present is described on p. 689.

For foreign bodies in the rectum, see p. 779.

Fæcal Accumulation. This may be regarded as a condition which is mid-way between severe constipation and actual obstruction ; it is, however, distinctly rare. The bowel, usually the lower half of the colon and occasionally the cæcum, becomes packed with hard masses of fæces, which may be doughy or even stone-like in consistency, and form a large tumour distending and dragging down the various portions of the colon by its sheer size and weight, the mesocolon also becoming elongated. This displacement of the colon tends naturally to the formation either of a kink or a volvulus. The continual pressure of these hard masses of fæces upon the bowel wall sooner or later gives rise to ulceration of the mucous membrane, numerous ulcers with a mucopurulent, blood-stained discharge being formed. These are known as *stercoral ulcers*, and when present they are very liable to give rise to acute perforation. Such ulcers are also often seen, as also is the whole condition of fæcal impaction, above a definite chronic or subacute obstruction of the colon (see p. 681).

This condition is usually seen in constipated women or drug takers ; also in patients with an anal fissure. Griping pain is complained of, together with vomiting, malaise, fever and ill-health. The breath is offensive, the tongue foul. Some of these patients complain of a diarrhœa which is really an overflow comparable to that which occurs in the bladder with retention. On examination of the abdomen, a round, sausage-shaped, elongated tumour will be felt, which may be doughy or of stony hardness and lies in the line of the colon. It is usually tender, nodulated and may be indentable by the fingers. The rectum will be found to be full either of a pultaceous mass of fæces or of large, rock-like scybala. Tenesmus, diarrhœa and a mucopurulent discharge from the rectum may be present.

Treatment. If it is thought that a definite organic obstruction is present operation will be necessary, but otherwise warm olive oil should be run into the rectum through a tube and funnel, and after some hours one or more large enemata are given. By this means the lower part of the bowel may be cleared out. In some cases it will be necessary to give an anæsthetic, stretch the anal sphincter and break up and remove the hardened fæcal masses with the fingers or an instrument. This must be done with great care in order not to damage the bowel wall. Purgatives and opium-containing drugs should be avoided carefully.

Intestinal Stasis. This name is given to any condition in which there is evidence that the passage of the bowel contents is delayed so that toxic materials of various kinds are absorbed into the general circulation and carried over the body. To the result of these toxins circulating in the blood stream certain enthusiasts have attributed almost every variety of disease of such various types as neurasthenia, osteoarthritis, uterine fibroids, chronic mastitis, carcinoma, duodenal ulcer, and so on. The actual cause of the primary stasis has been attributed to many things, especially to the formation of adventitious bands and membranes fixing and kinking the bowel, the assumption of the erect attitude by man with consequent intestinal ptosis, and general atrophy of the intestinal muscles. Visceroptosis (see p. 655) thus may be closely associated with stasis.

Certain of these bands and membranes have been given names, though their actual origin is unknown. They are probably not inflammatory; they may be congenital and represent the result of embryonic fusions, while other authorities regard them as mechanical, in that they have developed as the result of stresses and strains produced by the dragging of various portions of the bowel upon its supports. This again may be associated with the assumption of the erect attitude, and is just as likely to be the result as the cause of overloading of the bowel and constipation.

(*a*) *Jackson's Membrane.* This is a membranous sheath often seen running downwards and inwards from the parietal peritoneum on the outer side of the ascending colon to the front of this portion of the bowel to which it is attached. It may even pass down over the cæcum and appendix, and undoubtedly in severe cases ties the ascending and transverse colons together and produces gross exaggeration of the hepatic flexure.

(*b*) *The Ileal Band* (*Lane's First Kink*). This is a band of adhesions occasionally seen running from the peritoneum at the back of the right iliac fossa to the wall of the ileum opposite to the mesentery and some few inches above the ileocæcal valve. The drag of this band may produce a kink in this portion of the bowel and thus cause delay in the emptying of the ileum into the cæcum. Certain enthusiasts go further and attribute to this band such a dragging effect upon the duodenum and stomach as they state will account for duodenal ulcers and diseases of the gall-bladder.

(*c*) Another series of bands and kinks has been described in the neighbourhood of the sigmoid colon (*Lane's Last Kink*).

(*d*) *Payr's disease,* which consists of kinking of the splenic flexure by adhesions in this neighbourhood.

Endless other bands and adhesions have been described and an infinitude of symptoms attributed to them. We should at least like to remind readers that all these conditions are frequently found to be present in patients in whom they are producing no symptoms whatever.

Clinical Features. It is impossible to discuss these here at length, as they may be of enormous variety and of great uncertainty. A selection from the following groups usually will be found to be present: Tiredness, lassitude, loss of weight, poor circulation, ptosis, sweating, pigmentation of the skin, nervous and mental phenomena, osteoarthritis and chronic mastitis, abdominal discomfort, pain, distension and flatulence. Diarrhœa and offensive motions are sometimes seen. An X-ray examination of the whole bowel will demonstrate often how much delay there is and where it is occurring. The actual constipation may not be very marked and the patient may imagine that his bowels are acting well.

Treatment. This is almost entirely medical, and medical text-books must be consulted. It cannot be laid down too strongly that there is really no satisfactory surgical treatment for constipation and stasis of this kind. It is only in the very severest cases that operation in the form of section of controlling bands, various short circuits or removal of the cæcum and ascending colon is required. Excision of the whole colon is not justifiable. In a few cases excision of the cæcum and ascending colon may be beneficial. If this is done the ultimate result is likely to be better if the ileocæcal valve is preserved and transplanted into the colon.

Intestinal Perforation. This is a condition which in most cases is due to injury or gunshot wounds, but is occasionally seen as the result of pathological phenomena. Thus it may follow the impaction of a gall-stone or foreign body, damage to the bowel wall as in a strangulated hernia, and the giving way of an ulcer in the bowel wall. The types of ulcer most likely to lead to this complication are in order of frequency, *typhoid ulcers, stercoral ulcers and tuberculous ulcers.* Diverticulitis and malignant disease of the bowel occasionally also will lead to perforation, while perforation of the appendix and of gastric or duodenal ulcers are described on pp. 706, 622, 639. When tuberculous disease of the bowel has been present (see p. 665), it is probable that the neighbouring coils are already matted together and the peritoneal space shut off by adhesions before perforation occurs, so that in this case only, general peritonitis is not likely to follow, but there probably will be the formation of a local abscess which if it bursts or is opened may give rise to a fæcal fistula. In other cases of perforation general peritonitis is almost certain to follow rapidly. A few rare cases have occurred of perforation of a simple septic ulcer in the small intestine, usually in the ileum, of solitary cæcal ulcers and of ulcers due to septic infection of a Peyer's patch. We have seen two instances of this.

In many of these cases the symptoms of perforation may be masked by those of the pre-existent disease which has caused the perforation. There, however, will be shock and collapse, severe spreading pain, subnormal temperature, intense rigidity and tenderness, vomiting and a pulse which soon rises rapidly until all the signs and symptoms of general peritonitis are present (see p. 537).

The *treatment* of such a perforation consists in immediate operation to suture the opening, the only exception being in the case of tuberculous perforations. Here it is better to wait a while, as there is considerable chance of a local abscess forming, while the adhesions will render any perforation very difficult to find. Even if later a fæcal fistula forms, it is quite possible that this will close spontaneously, so that there is no urgency about performing an operation in an attempt to close it.

Typhoid Perforation. This usually occurs in the third or fourth week of the disease and in about 3 per cent. of cases ; it is most unlikely in the first ten days, but is sometimes seen considerably after the third week. In very mild ambulatory cases it is occasionally the first sign of the disease, but is naturally far more likely to occur in severe cases with much distension. It is most common in young men and is generally in the lowest 3 feet of the ileum ; it has also been seen in the colon and appendix. The perforation is usually quite small, and is not surrounded by any zone of induration, though the whole bowel wall in this disease will be found to be œdematous and infiltrated.

It must be remembered that at the time of perforation the patient is already desperately ill. The symptoms usually consist, therefore, of marked collapse, the temperature falling, and the pulse rising rapidly. There probably will be severe abdominal pain, but this may have been present before the perforation, as also may tenderness, and the patient may be too toxic to call attention to it. Rigidity, if present, is a valuable sign, but the patient is usually so weak that this is absent. Distension has probably been present for some time before and has probably already caused loss of the liver dulness. Leucocytosis (previously absent), increasing distension and vomiting soon set in. In many cases so ill is the patient beforehand that the diagnosis of perforation is exceedingly difficult. Much local pain and dulness on the right side of the abdomen are always suggestive of perforation. The only *treatment* consists in immediate operation, the abdomen being opened by a right paramedian incision and the cæcum and lower ileum examined. The perforation may be difficult to find, but adherent flakes of lymph will point it out; in searching for it the friable and soft condition of the bowel must be carefully remembered. When found, the perforation is closed by Lembert sutures and an omental graft stitched over it, while it must be remembered that more than one perforation may be present, and other suspicious areas should be treated similarly; the peritoneum should be drained afterwards. The mortality of typhoid perforation treated by operation is at least 70 per cent; without operation it approximates to 95 per cent.

In a few cases actual gangrene of some inches of the bowel wall will be found.

INFLAMMATORY DISEASES OF THE BOWEL

Localised Phlegmonous Enteritis. A few cases of acute localised suppurative inflammation of short lengths of the bowel have been recorded. They have been due to streptococcal infection and have been rapidly fatal from peritonitis. There is a sudden onset with rigors, high temperature and acute abdominal pain, vomiting and rigidity. No sign of vascular obstruction or foreign body was present to account for the condition.

Regional Ileitis (Crohn's disease). A similar condition (possibly exactly the same) has been described under the above name as an acute or subacute condition occurring in young adults in the last two feet of the ileum. There is a segment of bowel with ulceration of the mucous membrane and great hypertrophy of the connective tissue, with much thickening, œdema and abscess formation in the submucous layer. In some cases this has definitely been due to tuberculosis. It gives rise to signs suggestive of acute appendicitis and later to severe pain, vomiting and symptoms of intestinal obstruction. The best *treatment* is laparotomy and resection of the affected segment with end-to-end anastomosis.

Diverticulosis of the Jejunum is occasionally met with, usually in persons over middle age. Clinically it gives rise to little or no trouble unless infection and abscess formation occur in one of the diverticula, when acute symptoms supervene and perforation may occur; in either case prompt laparotomy is called for. The condition is recognised easily if a barium meal be given and X-ray films taken. The ætiology is rather obscure, some authorities regarding the condition as due to bulging of the mucosa through the muscle walls, through the weak spots where the vessels enter, while others regard the sacs as traction diverticulæ, due to shortening of the vessels from arteriosclerosis. Such diverticula are always on the mesenteric border of the bowel and may bulge up between the two peritoneal layers; unlike duodenal diverticulum, which is usually solitary, these jejunal pouches are invariably multiple and vary in size from a pea to a tangerine orange.

Colitis. Two forms of colitis are described, which, though usually regarded as coming within the realm of the physician, not uncommonly require surgical treatment.

(A) *Mucous Colitis.* This is the milder variety, and gives rise to griping abdominal pains, accompanied by diarrhœa and the passage of much mucus in the stools; the colon will be tender and may be felt to be in spasm, while the condition is frequently accompanied by grave neurasthenic symptoms. The treatment of this condition is almost entirely medical, though, should it persist and become severe, the same forms of surgical treatment which are described for the other variety may be necessary.

(B) *Ulcerative Colitis.* This is a much more severe condition, in which the mucous membrane of the colon becomes ulcerated and much destruction of tissue occurs. The ulcers have raised, sloughy edges, while the surrounding mucous membrane is œdematous and inflamed. The ulceration may end in perforation, or may involve large vessels in the bowel wall and give rise to profuse hæmorrhage.

The condition gives rise to diarrhœa, with the passage of mucus, blood, and pus in the stools, which are very offensive. Pain and tenderness are present over the line of the colon, which when in spasm may be felt as an elongated swelling, while the patient rapidly becomes thin, loses strength, and may have a hectic temperature. The disease frequently proves fatal, and is most common in young adults. Examination with the sigmoidoscope will show the ulcers and inflamed condition of the colon as far as it can be examined.

Treatment. Here, again, the treatment is medical in the first instance, but when this fails, and before the patient becomes too bad, the aid of the surgeon should be called upon. Two procedures are possible:—

(*a*) An opening may be made into the bowel, through which it can be irrigated. This is best done by means of an appendicostomy (see p. 721); the irrigating fluid must be non-toxic and non-irritating, such as warm saline, boracic solution, or nitrate of silver 1 in 12,000; it is run into the bowel through the appendix by means of a small rubber tube and passes out through the anus. The bowel must not be allowed to become distended.

(*b*) The fæcal current may have to be diverted from the colon, as well as the irrigation being carried out. This will be best assured by performing a colostomy in the ascending colon or a cæcostomy. In very severe cases, where the cæcum is involved, even an ileostomy may be necessary; an ileosigmoidostomy is to be avoided, as fæces will still pass back into the now blind colon owing to antiperistaltic movements.

Dysentery. In this condition also, though the cause is different, an extensive and deep ulceration of the walls of the colon occurs, this particularly affecting the left-hand side of the colon. The submucous layer becomes infiltrated, and the ulcers spread and eat deeper into the bowel wall, even the peritoneum occasionally becoming involved, though perforation is rare. Certain of the complications and after-effects are entirely surgical, such as abscess of the liver (see p. 737), and the formation of a dysenteric stricture of the bowel (see p. 667). Steps must be taken by bacteriological investigation to ascertain whether the dysentery is bacillary or amœbic. In the former case mucus and blood predominate in the stools, in the latter case pus, while in the bacillary form the ulceration is far more superficial than in the amœbic variety.

Treatment. The treatment of the primary condition is, in the first instance, medical, but should the disease become chronic, as not infrequently happens, the condition may pass into one very closely resembling ulcerative colitis, and the same type of surgical treatment, therefore, may be necessary, *i.e.*, either appendicostomy by means of which the bowel may be irrigated with saline solution, protargol or argyrol, or else a diversion of the fæcal current. This may be done either by means of a cæcostomy, a temporary ascending colostomy, or, in some instances, an ileosigmoidostomy. This is, however, not free from objections.

Appropriate treatment according to the cause must also be given, *i.e.*, emetine in amœbic cases and serum in bacillary cases.

Diverticulitis (Pericolitis Sinistra). This is a not uncommon condition which is met with in stout people of over forty-five, usually men, and frequently with a previous history of years of constipation. The condition affects almost entirely the descending and pelvic colons and very rarely occurs in the ascending colon. The first change appears to be that multiple, bluish-black, bottle-shaped diverticula form in this part of the bowel near its mesenteric border, consisting usually of small protrusions of the mucous membrane, which bulge out through the weak spots in the bowel wall where vessels enter, being probably pulled out by shortening and thickening of the vessel wall due to arteriosclerotic changes; later this sac extends into and fills up an appendix epiploica. The amount of fat usually present in the mesentery probably produces atrophy and weakening of the muscle wall. The presence of gas and the effects of constipation and straining at stool cause these diverticula to increase in size, and their fæcal contents stagnate and form hard inspissated concretions. A few of these diverticula may be congenital, but as a rule they do not appear till middle age, and repeated X-ray examinations will show new diverticula appearing and old ones enlarging. Inflammatory changes follow the formation of the diverticula and do not precede them. There thus are formed a series of structures on the left side of the bowel almost exactly similar to the vermiform appendix on the right side (*Diverticulosis*). Other septic foci are often present in the alimentary canal, such as cholecystitis, septic teeth, etc. Some authorities state that 10 per cent. of normal persons over forty-five years of age have symptomless diverticula present.

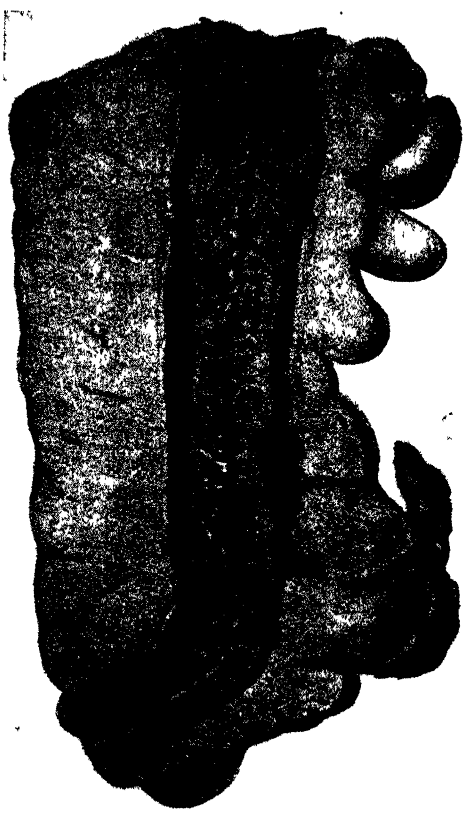


FIG. 242. Diverticulitis of the colon, showing extensive deposit of fibrolipomatous tissue, with acute inflammation, gangrene and perforation of one diverticulum. The bowel has been converted into a long tubular stricture.

Any one of these diverticula may develop pathological lesions almost exactly similar to those of the appendix itself; thus:—

(*a*) *Acute Diverticulitis* may occur, the diverticulum becoming acutely inflamed, and the inflammation involving the peritoneal coat in its neighbourhood; the condition may advance until gangrene or perforation of the diverticulum occurs. When this happens, although a local abscess may form, the virulence of the infection is generally very great, so that the more likely result is a general peritonitis.

(*b*) *Chronic Diverticulitis.* A more common change, and one which does not occur in the vermiform appendix, is a process of very chronic inflammation spreading to the bowel wall around these inflamed diverticula and running up and down for several inches, giving rise to the deposit within the bowel wall of large masses of fibrous, or rather fibrolipomatous, tissue, this being especially seen in the submucous layer. After some months or years this results in a large, hard, sausage-shaped tumour, the bulk and the contracting scar tissue of which produce gross stricturing and narrowing of the gut for some inches; this tumour will resemble malignant disease of the colon very closely.

This diverticular mass becomes very adherent to surrounding structures, and lying as it does at the left side of the pelvis it is especially liable to become adherent to the bladder. When this occurs the spread of inflammation and the onset of ulceration not infrequently will give rise to the formation of a communication between the colon and the bladder at this point (Intestino-vesical fistula, see p. 878). Diverticulitis probably causes this condition more often than does malignant disease.

(*c*) Many cases remain for years without forming a large hard mass, the diverticula merely growing in size and number and becoming inflamed and tender with recurrent exacerbations.

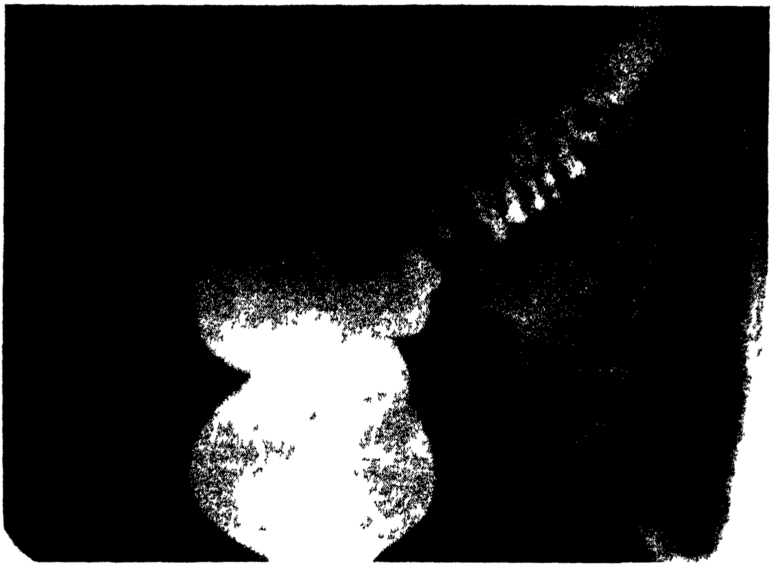
Clinical Features. The clinical features of this condition are fairly definite.

(*a*) In the acute condition they almost exactly resemble those of appendicitis on the left side, and usually occur in a stout, middle-aged, constipated patient; the condition may terminate either in recovery, abscess formation, or peritonitis (see pp. 708–715).

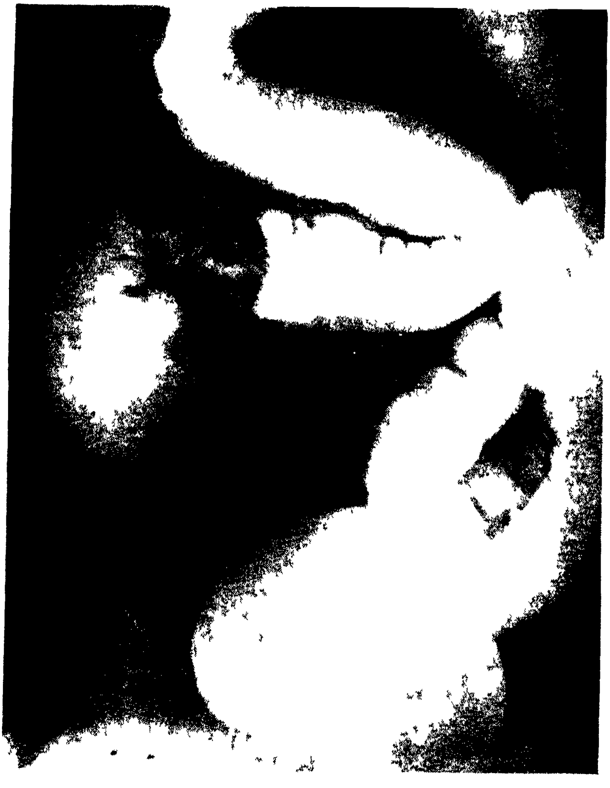
(*b*) In the chronic condition the symptoms very closely resemble those of carcinoma of the pelvic colon; there is thus increasing constipation, and the gradual onset of griping pains and abdominal distension in a middle-aged patient, preceded for some months by the passage of mucus in the stools; blood is not as a rule found in the stools. After a long period the condition may terminate in acute obstruction.

On examination a hard, tender, sausage-shaped lump will be felt either in the left iliac fossa or, on rectal examination, lying in the pouch of Douglas. The X-ray appearances following a barium enema also will be somewhat similar to those of carcinoma of the colon (see p. 671), save that the stricture visible in the picture is in this case long and tubular, and occasionally isolated diverticula may be seen close by in which some bismuth will remain after the rest has passed away. The tongue is usually dirty in diverticulitis and clean in carcinoma. Probably a small proportion of these chronic cases, if untreated, ultimately become carcinomatous, whereas, on the other hand, their existence, accounts for most of the instances thought to be inoperable pelvic carcinomata, which have disappeared spontaneously. Many cases are practically symptomless, except for repeated attacks of inflammation giving rise to pain and fever. We have recently seen two cases in which a diverticulum, previously unsuspected, perforated suddenly and gave rise to general peritonitis while the patient was straining at stool.

PLATE V.



A Barium enema showing diverticulitis of the pelvic colon



B. Barium enema showing filling defect of the right side of the transverse colon due to carcinoma (an uncommon situation)

Treatment. Prophylactic treatment may be of value and consists in plenty of paraffin and a diet with as little residue as possible. Above all, nothing containing pips should be eaten. In the acute stage the treatment is similar to that of appendicitis, though somewhat less urgent. If possible, the inflamed diverticulum should be removed or an abscess may require drainage. Perforations, if present, should be sutured or otherwise covered over.

In the chronic stage, if no obstruction is present, medical treatment may be tried first. This consists in large quantities of olive oil or paraffin by the mouth (two or three ounces a day), while once a day six or eight ounces of olive oil should be run into the rectum and the patient kept with the foot of his bed up and the oil in his rectum for as long as he can retain it, if possible for several hours. High up rectal washouts on the Plombière's system are also valuable when all acute symptoms have passed off. If it is thought that much spasm is present, atropin will help. If this treatment fails, the diverticular mass should be resected and the ends of the bowel sutured, or, failing this, a lateral short circuit may be performed. If marked obstruction is present, this should be preceded for some weeks by a temporary colostomy. The excision of these masses may be very difficult on account of adhesions.

Tuberculous Disease of the Bowel. Apart from tuberculous peritonitis and tuberculous involvement of abdominal glands (Chapter XIII., pp. 550–553), the disease is seen to affect the intestine in two ways.

(A) **Hyperplastic Ileocæcal Tuberculosis.** This form of the disease almost invariably occurs in the cæcum, appendix and lower end of the ileum; very rarely it is seen elsewhere in the colon. Tubercles are deposited in the submucous layer, and the wall of the bowel becomes infiltrated and thickened by the formation of much fibrolipomatous tissue. The peritoneum becomes rough, thickened, adherent to surrounding structures, and may be covered with miliary tubercles, while the mucous membrane is often granulating, ulcerating and polypoid. This, together with the formation of scar tissue, produces obstruction of the bowel lumen, while peristalsis is interfered with by the muscle infiltration. Enlarged glands are present in the mesentery close by, while the adhesions and the contraction of scar tissue may drag the large tumour to which the condition gives rise up into an abnormal position. Caseation occurs in the wall of the bowel, and cold abscesses will form either in the bowel wall or outside it. These ultimately may burst out through the abdominal wall and give rise to external sinuses. Tubercles are often seen in the peritoneal coat.

Clinical Features. The onset of this disease is insidious, and the symptoms variable. In many cases indigestion, discomfort in the right iliac fossa, loss of weight and alternate diarrhœa and constipation will be noticed, and occasionally blood will be found in the stools. These symptoms may persist for two or three years, while gradually griping pain sets in and the constipation becomes more marked, even approaching a condition of subacute obstruction. In the later stages borborygmi, with visible coils of bowel and local distension, will be noticeable.

At some stage in the disease a firm, knobbly tumour will be detected in the right iliac fossa or slightly higher up, and the lower border of such a tumour is usually better defined than the upper border, where it passes into the colon. This swelling is dull on percussion, tender on pressure, and will be fixed or movable according to how long it has been present. Slight pyrexia is sometimes present, while abscesses may arise which burst externally and give rise to sinuses. Search should be made for tuberculosis in other parts of the body.

It will be seen that this condition closely resembles carcinoma of the cæcum. It is, however, of longer duration and slower growth, and the age at which it occurs is usually younger, while the presence of tuberculous lesions elsewhere is of value in establishing the diagnosis. Actinomycotic lesions of the cæcum (see p. 718) closely resemble this condition.

Treatment. This consists essentially in operation, and in many cases the diagnosis is not established for certain until the abdomen is opened. A formal resection of the cæcum should then be performed, including the appendix, about 4 inches of the ileum, the ascending colon and the first few inches of the transverse colon, exactly on the same lines as for carcinoma of the cæcum (see p. 674). The ileum is then joined to the transverse colon by side-to-side or end-to-side union. If for any reason excision is impossible, because of adhesions, sinuses, or the patient's general condition, a short-circuit should be performed and the cæcum be excluded from the fæcal stream. The results of both these operations are very satisfactory, though pulmonary embolus is a not uncommon complication.

(B) **Tuberculous Ulceration.** This is a common condition in young patients and is frequently associated with either phthisis or tuberculous peritonitis. The ulcers are shallow ulcers with thin, undermined edges, multiple, round, and most common in the lower part of the ileum. Infection almost invariably commences in the Peyer's patches and as the result of bacilli which have been swallowed in milk or in the sputum. The ulcers spread circularly round the bowel following the blood vessels and lymphatics, and in the process of healing, therefore, the contraction of scar tissue leads to a stricture (tubercular stricture). Such strictures are often multiple, usually in the lower yard of the bowel, may be accompanied by ileocæcal tuberculosis, and sooner or later will give rise to symptoms of obstruction. Miliary tubercles often will be seen upon the peritoneal coat, while adhesions and enlarged or caseous mesenteric glands are usually present.

Clinical Features. In the early stages the signs and symptoms consist in abdominal pain, diarrhœa, pyrexia and the associated symptoms of tuberculous peritonitis (see p. 553). As stenosis gradually sets in, the symptoms of subacute obstruction will supervene (see p. 681), while, in addition to this, masses formed by enlarged glands or matted bowel often may be felt. Tubercle bacilli often will be found in the fæces.

Other complications may follow upon tuberculous ulceration of the bowel: thus perforation is occasionally seen, and this gives rise more commonly to a local abscess than peritonitis. In other instances a cold abscess may form around the bowel; this is prone to discharge itself through the umbilicus, and then it is not infrequently followed by the formation of a fæcal fistula at this spot.

A few instances of "*solitary ulcer of the cæcum*" have been described; these have usually proved to be tuberculous.

Treatment. In the early stages, before stenosis sets in, this is entirely medical, but when obstruction is commencing, laparotomy will be necessary. In most instances, where there are several strictures close together, it is wise to excise the affected coil of bowel and join the ends by end-to-end union. In other instances, this may be rendered impossible by adhesions, etc., and then a lateral anastomosis to short-circuit the stricture should be performed.

Actinomycosis. This granuloma occasionally involves the bowel and then almost invariably commences in the neighbourhood of the appendix and cæcum, invading the bowel wall from the mucous membrane. As in most instances this commences in the appendix, or develops as a sequel to an attack of appendicitis, it will be described in full on p. 718.

FIBROUS STRICTURE OF THE INTESTINE

This is not a very common condition, but is seen as the result of several different causes. A fibrous stricture, unless congenital, is almost always due to the contraction of scar tissue, produced as the result of ulceration of or damage to the bowel wall. The causes of fibrous strictures are, therefore, as follows :—

(*a*) As the result of the healing of ulcers which have tended to encircle the bowel wall. This is specially seen in the small bowel as a result of tuberculous ulcers, and in the case of the rectum and large intestine, of syphilitic and dysenteric ulcers. Such strictures are known as tuberculous, syphilitic and dysenteric strictures (see also p. 662). Typhoid ulceration probably never leads to stricturing. Gonorrhœal strictures are sometimes seen in the rectum.

(*b*) After a strangulated hernia a stricture may form where the bowel wall was nipped in the constriction, ulceration having occurred at this spot. This is usually in the small bowel, and is a narrow annular stricture. The condition is rare, and symptoms usually come on within three months of the strangulated hernia. A similar condition is sometimes seen after reduction or spontaneous separation of an intussusception.

(*c*) Tight obstruction of the bowel by means of an outside band or adhesion not infrequently leads to this condition, and after the band has been cut away the fibrous stricture of the bowel will be seen to persist. A similar condition is at times seen to follow tight impaction in the bowel of a foreign body, such as a gall-stone.

(*d*) What may be termed a traumatic stricture is seen sometimes to follow upon an end-to-end anastomosis, or the suturing of perforations or openings in the bowel. This should be regarded as evidence of bad technique and faulty suturing, as the condition should never be seen when the operation has been properly performed. In this case the symptoms usually come on within four months of the operation.

(*e*) Fibrous stricture sometimes occurs at the base of a Meckel's diverticulum (see p. 654) as a result of ulceration.

Strictures of this kind do not, as a rule, cause complete obstruction, but rather a chronic obstruction, tending to become more and more marked. It should also be remembered that the tendency to obstruction will be increased by the presence of adhesions, twisting, kinking or bending of the affected segment or congestion of its mucous membrane.

Clinical Features. These strictures are far more commonly seen in the small intestine, where, the contents being entirely liquid in nature, considerable stenosis of the bowel may occur without very much in the way of symptoms arising. Indigestion, pain and flatulence may be complained of, with gurgling noises, distension and increasing constipation, while, finally, in some cases an attack of acute obstruction may supervene (see p. 677).

In the colon the contents are more solid and symptoms, therefore, arise sooner. They are those of obstruction of the large bowel as distinct from blockage of the small bowel (see p. 681). In all instances of fibrous stricture an X-ray examination, with the aid of a bismuth or barium meal or enema in the case of the colon, will be of the greatest assistance.

Treatment. Though in the early stages the symptoms may be relieved by means of diet, purgatives and enemata, more serious obstruction is certain to supervene sooner or later. At some time or other, therefore, surgical treatment will become necessary, and it is of the greatest importance that this should be undertaken if possible before serious obstruction sets in, so that it is an operation of convenience rather than of emergency.

When no serious degree of obstruction is present the stricture should be found, and the affected portion of the bowel may be resected or a lateral short-circuit above and below the stricture performed. In some cases, where the stricture is narrow and the bowel wall sound, an enteroplasty may be performed, the stricture being divided longitudinally, and the incision then being sutured in two layers horizontally ; but cases suitable for this procedure are very rare.

The treatment when acute obstruction is present will be described on p. 680. Here, in many cases, two operations will be necessary, the first merely consisting in the formation of an artificial anus above the stricture.

NEW GROWTHS OF THE INTESTINE

(A) New Growths of the Small Intestine. (1) *Simple.* These are very rare, an adenoma being probably the least uncommon ; these arise in the secretory glands of the bowel, and are occasionally multiple. Fibroma, lipoma, papilloma and myoma are also occasionally seen. The tendency of all these simple growths of the small intestine is to become pedunculated and project into the bowel lumen, so that they cause very little in the way of symptoms, but it should be remembered that they are highly likely to lead to an intussusception (see p. 692). Hæmorrhage and symptoms of obstruction are sometimes caused by them, and when encountered during a laparotomy

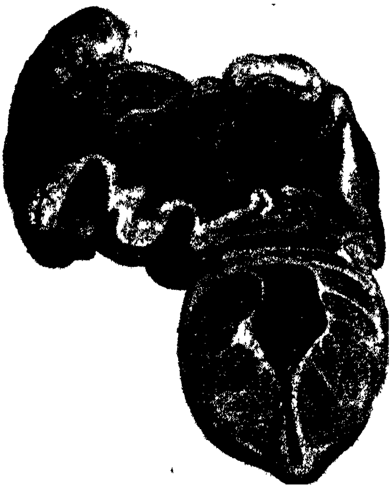


FIG. 243. A simple myoma of the pelvic colon.

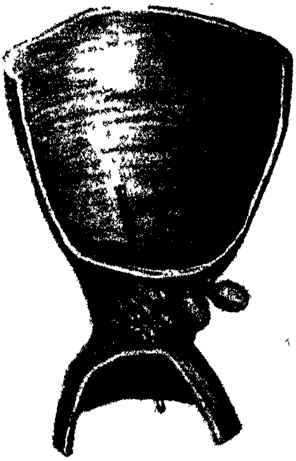


FIG. 244. Carcinoma of the colon of the ring type with marked obstruction.

they should be removed, if necessary, with the affected segment of bowel.

(2) *Malignant.* These are also rare in the small intestine.

Carcinoma is very rarely seen, but is usually in the lower part of the ileum, where it surrounds the bowel and sooner or later produces obstruction. It is usually of the columnar type, and gives rise to increasing constipation and loss of weight. After a time pain and vomiting set in, distension, visible peristalsis and a step-ladder pattern being noticeable, but from the fluid nature of the bowel contents these symptoms do not arise until late. A tumour may be felt sometimes. The treatment consists in resection of the portion of the bowel involved with deep section of the mesentery, on the lines described on p. 698.

Sarcoma is more common than the above condition, and it is also seen in the cæcum. It commences in the submucous layer, and may infiltrate either all the bowel coats to form a large mass or project towards the lumen to form a pedunculated swelling ; secondary growths in the glands and liver appear rapidly. The condition is most common in children, in whom it may give rise to an intussusception. The treatment for the condition is the same as that for carcinoma (see above).

Secondary carcinoma is common in the small intestine, either in the form of multiple nodules or one or more isolated larger growths. Nothing can be done for this.

(B) **New Growths of the Large Intestine.** (1) *Simple.* Simple growths of the colon are rare with the exception of **multiple adenomata,** which are not infrequently seen over the greater part of the left-hand side of the colon and the rectum. They are usually pedunculated, of a bright red colour, and are very liable to become malignant. In some instances these seem to be hereditary and to be transmitted by either sex. As they are nearly always fatal either from hæmorrhage or malignant change, the families tend to die out. The condition is most often seen between the ages of twenty and forty, and gives rise to severe diarrhœa, tenesmus, blood and mucus in the stools, pain and loss of weight. The growths can be recognised at once with the aid of the sigmoidoscope, although nothing can be felt in the abdomen. The only treatment which is likely to give permanent benefit is excision of a large portion, or even of the whole, of the colon, though the symptoms may be relieved temporarily by douches or local excisions.

(2) *Malignant.* **Carcinoma of the Colon.** This is a very common disease of the colon, where it is usually a columnar carcinoma and, as stated above, the presence of adenomatous polypi in the bowel is a strong predisposing factor in the development of carcinoma. In the colon carcinoma is undoubtedly of a low grade of malignancy, spreading slowly, and very rarely giving rise to metastases, except in the abdominal cavity ; it not infrequently undergoes colloid degeneration. It may occur in any part of the colon, the parts affected, in order of frequency, being the pelvic colon, the cæcum and ascending colon, the splenic flexure, the transverse colon, the hepatic flexure, and the descending colon.

It appears to the naked eye in three forms :—

(*a*) *The Scirrhous Type.* This is the commonest form, and the one which almost always occurs in the left side of the colon. The growth follows the lymphatic vessels and grows round the bowel, is very small in bulk, and the fibrous tissues rapidly constrict the gut lumen, giving rise to an annular constriction, through which only a probe may pass. Only a very small portion of the bowel is involved, and it looks from outside as though a string had been tightly tied round it (ring stricture). The growth extends upwards and downwards in the submucous layer, but is only visible to the naked eye for a distance of about an inch as a rule, while at the summit of the stricture is a small ulcerated, bleeding surface. In this case there is atony and paralysis of the bowel below the growth, while the bowel above the growth is much hypertrophied and dilated from the chronic obstruction present; in spite of the obstruction, the function may be carried on well for some time, and the cæcum will be grossly distended wherever the growth is. The mucous membrane of the bowel for a considerable distance above the growth is red, congested and inflamed. Stercoral ulcers will occur from the pressure of hard fæces. Gangrene and perforation of the bowel above the growth are sometimes seen, both occurring almost always in the cæcum.

This type causes obstructive symptoms early, spreads slowly, and is intermediate in malignancy between the other two types.

(*b*) *The Hypertrophic or Fungating Type.* This is a rarer type, specially liable to undergo colloid degeneration, which only occurs in the right-hand side of the colon, and gives rise to a large, fungating, cauliflower-like mass, projecting into the lumen of the bowel. It does not cause obstructive symptoms for a long time, and is probably the least malignant form of the disease, the tendency to involvement of glands and formation of metastases being inversely proportional to the upward and outward growth of the tumour.

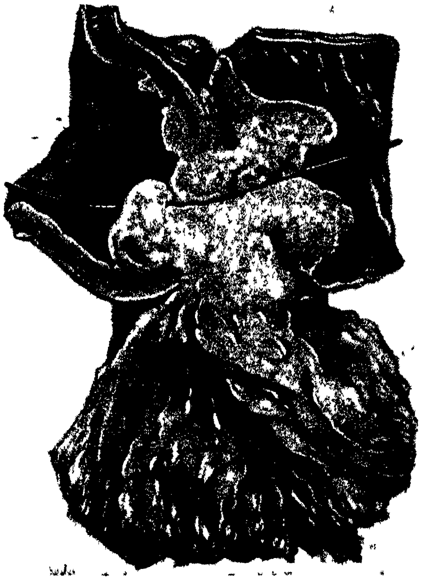


FIG. 245. Carcinoma of the transverse colon of the fungating type.

(*c*) *The deep indurated ulcer*, which is the least common form, and which eats its way deeply down into the bowel wall and gives rise to metastases and glandular involvement more rapidly than do the other varieties.

The "rosette type" of growth occasionally seen in the rectum is very rare in the colon.

In these last two types of growth the changes in the bowel above are similar to those described above, but less marked, and in all types the lumen of the bowel below the growth is occasionally ballooned, but hypertrophy is absent. The growths contract adhesions to other structures in their neighbourhood, such as the ileum, omentum, and abdominal parietes, at varying periods; such adhesions are, however, not necessarily caused by malignant infiltration, but are often inflammatory. Infection and even suppuration in and around the growth are not uncommon, and abscess formation or cellulitis in the extraperitoneal tissues, leading sometimes to fæcal fistula, should be looked for. In the case of growths of the cæcum, such a condition will resemble an appendix abscess closely.

The growth spreads primarily in the submucous layer and further up the bowel wall than down it. The lymphatic glands become involved after a time: first those in the mesentery and on the bowel wall (paracolic), then those about the centre of the mesentery and finally those in the mesenteric root; from here the growth spreads to the lumbar glands and those in the hepatic fissure, while secondary growths in the liver and multiple nodules scattered all over the peritoneum and its contents will occur in due course, this latter state being accompanied by ascites. Distant metastases are very rare, but "seedling growths" occur by direct implantation lower down the bowel. Internal fistulæ between two loops of bowel, between the stomach and colon or the colon and bladder, are occasionally seen.

Clinical Features. The prominent clinical features depend largely upon:

(*a*) Whether the growth is in the left-hand or right-hand side of the colon.

(*b*) Whether it is of the scirrhous or hypertrophic type.

The initial symptoms for the first few weeks are in all cases of a vague type. The disease seldom occurs under forty, is rather more common in men than women, and possibly in those who are of a constipated tendency. The patient may complain of flatulence, indigestion, vague, griping abdominal pains coming on in attacks, and increasing constipation. Anæmia is often marked, and sometimes sufficiently intense to resemble pernicious anæmia. The tongue is often remarkably clean, while De Morgan's spots are not uncommon on the skin (see Vol. I., Ch. VIII.).

(1) When the growth is on the right-hand side, *i.e.*, in the cæcum, ascending colon or hepatic flexure, in addition to the above vague symptoms the patient frequently complains of a swelling, and on examination a large, hard tumour will be felt in this position. In this type of growth diarrhœa alone, or alternating diarrhœa and constipation, is more likely to be complained of than pure constipation. Visible blood and mucus in the stools (see below) are not likely to occur in these cases, but chemical and microscopic examination may demonstrate the presence of blood.

(2) On the left-hand side of the colon, however, the growth probably will be of the "ring" type, small and difficult to palpate, but with well-marked, increasing constipation. Visible blood and mucus in the stools are nearly always complained of, while after the growth has been present for some time, aching pain in the right iliac fossa due to visible and palpable distension of the cæcum will be present. The lower the growth is the more marked will be the blood and mucus in the stools, and the more closely the symptoms will resemble those of carcinoma of the rectum (see p. 802).

In the splenic flexure and descending colon the tumour is not likely to be felt. In the pelvic colon it can be ascertained sometimes by bimanual examination or be felt from the rectum lying in the pouch of Douglas, and in this latter case examination with the sigmoidoscope probably will demonstrate it. In the lower part of the pelvic colon "morning diarrhœa" is especially likely to occur. In the transverse colon the tumour is probably palpable and will be felt as a hard, movable tumour lying above the umbilicus. In all cases examination with X-rays and a barium enema and meal should be made; the lower the growth is in the bowel the more likely this method is to show a definite stricture.

As the condition progresses a well-marked state of chronic obstruction will set in, with more pain, more constipation and increasing distension, loss of weight and strength and anæmia; sooner or later, perhaps after one or two milder warning attacks, this chronic obstruction will become acute (see p. 682). This acute change not infrequently follows the taking of purgatives and is usually due either to the failure of compensatory hypertrophy or to the final blocking of the bowel lumen already reduced to the size of a quill, either by congestion or the impaction of some semisolid fæcal substance. During the chronic obstructive stage, borborygmi are often most noticeable, and the patient sometimes will state that they seem to pass up to and always end at the same spot in the abdomen, which is quite likely the site of the growth. In the later stages still, the growth may involve or press upon important nerves and so give rise to severe referred pains.

When acute obstruction sets in the pain increases and becomes continuous, the bowels fail to act altogether and great distension of the abdomen occurs, the distension being more marked in the epigastrium and flanks than in the central parts, while the whole abdomen gives a drummy, tympanitic note. Visible coils are not often seen, though the cæcal distension is marked, and vomiting only occurs late, sometimes not until the bowels have been absolutely constipated for ten days. It never becomes fæcal and the tongue will remain remarkably clean. Hiccough is troublesome, ballooning of the rectum is often felt, the temperature is subnormal, but often for some days the patient's pulse and general condition remain remarkably good. It cannot be too strongly insisted upon that it is the exception and not the rule to be able to feel a palpable tumour, except in the case of right-hand-side growths. Sometimes a collection of fæcal matter above the growth will be felt; this is comparatively soft, and pits on pressure.

With regard to the differential diagnosis, in the non-obstructed cases any tumour which can be felt will have to be discriminated from tumours of the gall-bladder, stomach or kidney, or of the female generative organs, and such conditions as ileocæcal tuberculosis and inflammatory masses in connection with the cæcum. Every case of irregular intestinal action or of obscure pain in the abdomen occurring in people over forty should raise the suspicion that this condition is present, and in many cases a purely exploratory operation is advisable.

Perforation of a Stercoral Ulcer. When acute obstruction due to carcinoma has been present for some days, it is not uncommon for a stercoral ulcer, almost always in the cæcum, to perforate and flood the peritoneum with fæcal matter. When this occurs there is a sudden increase of severe local pain and marked tenderness and rigidity over the perforation. The pulse rate rises, vomiting increases, the signs of general peritonitis supervene, and the patient dies rapidly.

Treatment. There is, of course, no treatment for these growths other than operation, but if it is obvious that secondary growths are present or that the primary growth, if felt, is so fixed that its removal is unlikely, an exploration need not be undertaken; an operation for relief will be necessary later on, when acute obstruction seems to be setting in. In some cases it is possible to delay or prevent the onset of acute obstruction by carefully controlling the diet and administering liquid paraffin and charcoal.

Many cases only come for operation when acute obstruction has already supervened, and it is perhaps a good thing that obstruction supervenes so early in many of the left-hand-sided cases, as they are then capable of being dealt with while they are in an operable state. From the point of view of operative treatment, this condition divides itself into four classes:—

(*a*) Those where acute obstruction is present and the growth is removable.

(*b*) Those where acute obstruction is present and the growth is irremovable.

(*c*) Those where no obstruction is present and the growth is removable.

(*d*) Those where no obstruction is present and the growth is irremovable.

It should be taken as a golden rule that, *when in these cases acute obstruction is present, the growth should never be resected and the ends of the bowel joined up there and then in one operation.*

(*a*) In group (*a*), when acute obstruction is present, the site of the growth is probably uncertain. The lower right-hand side is, therefore, the best place where the abdomen should be opened; one hand is introduced and the growth searched for and examined to see both where it is and whether it is capable of removal. This is best done by following the course of the colon up from the pelvis to the cæcum, and on no account must coils of bowel be allowed to escape. Some surgeons advise against this procedure, and state that instead of introducing the hand and discovering the growth a small opening should merely be made over the cæcum, the cæcum opened, and a tube introduced to drain it (blind cæcostomy). We do not approve of this procedure, as no information is obtained about the growth, and it may involve the patient in a totally useless second operation at a later date.

Having discovered the growth and determined that it is operable by noting that it is movable, that the liver is free from secondaries, that no distant glands are involved or seedling growths present, and that there are no nodules in the peritoneum, two procedures may be adopted :—

(1) An opening may be made in the bowel above the growth to relieve the obstruction. This may be a cæcostomy or a colostomy, and as, assuming that the growth is operable, it is only a temporary opening, if a colostomy is performed, it should have no spur and may with advantage be of the type advocated by Devine. At a later date, when the obstruction has passed off, say in from ten days' to three weeks' time, the abdomen is reopened, the growth resected, and the ends of the bowel joined up. The temporary drainage opening probably will close itself after this, and care should be taken to make the colostomy opening some distance away from the tumour, that it may not interfere with the subsequent resection of the growth. We regard this as a sounder procedure than the following one :—

(2) *Paul's Operation.* This consists in delivering the growth and removing it there and then. No attempt is made to join the ends of the bowel together, but a Paul's tube is introduced into each open end. At a subsequent date the ends are either joined together by suture or by crushing the diaphragm of bowel wall intervening between them with a special clamp. Our objection to this method is that, when the patient is acutely obstructed and the gut grossly distended and sodden, it is neither easy nor satisfactory to perform a free removal of the growth and its lymphatic drainage area. To attempt to suture the bowel immediately after removing the growth when obstruction is present is to court disaster, for the sodden and infiltrated bowel wall is most unlikely to hold stitches satisfactorily.

(*b*) Here, where obstruction is present and the growth is irremovable, the question of a resection later on does not arise. The obstruction, therefore, must be relieved permanently, and the choice lies between a permanent colostomy with a spur or the short-circuiting of the growth by means of a lateral anastomosis. This latter procedure is, perhaps, a trifle more risky, but, if successful, is far more satisfactory to the patient than a permanent opening.

A patient with an inoperable growth of the colon, whose obstruction has been permanently relieved by operation, often will live a long time in comfort, as the growth is slow and of low malignancy ; thus three, four and five years of comfort are by no means an unusual result. The anastomosis performed should be a simple lateral anastomosis, without cutting the bowel across. No form of total or partial exclusion of a portion of the gut is either necessary or advisable.

(*c*) Here, where no obstruction is present and the growth on opening the abdomen is found to be removable, the operation to remove it and to re-establish the continuity of the bowel should be proceeded with straight away. The methods of removing growths in various parts of the colon are described shortly below. Many surgeons advise that, even when no obstruction is present, a preliminary temporary colostomy should be performed ten days or so before the resection of the growth. This probably does diminish the operation mortality slightly.

(*d*) If, on the other hand, no obstruction is present, and on laparotomy the growth is found to be irremovable, a short-circuit should be performed if possible, to prevent any possibility of obstruction setting in in the future. This may not be possible in the case of growths very low down in the pelvic colon, and here a colostomy may be the only procedure available.

When removing growths of various portions of the colon the following general principles should be remembered :—

(*a*) More bowel should be removed above the growth than below it, at least 5 inches above and 3 inches below being taken away if possible. In addition to this a deep V-shaped section of the mesentery right down to its root should be made.

(*b*) After any of these operations a small tube should be introduced into the cæcum through a separate stab wound for a few days. This acts as a safety valve, letting out gas and fluid fæces and preventing distension. A possible alternative to this in the lower part of the colon is to pass a flatus tube up through the anus and through the anastomosis into the bowel above it.

(*c*) The contents of the colon are virulently septic.

In the case of growths of *the cæcum and ascending colon* the same operation, known as Forster's operation, should be performed. The cæcum, ascending colon and hepatic flexure are mobilised by incising the peritoneum on their outer side and stripping them up inwards. The lower 3 inches of the ileum (whose blood supply may be endangered), the cæcum, ascending colon, and an inch or two of the transverse colon, together with a deep V of the artificial mesentery created, should be removed in one piece. The ileum is then united to the transverse colon, either by side-to-side, end-to-side or end-to-end anastomosis, this being our order of preference. Care must be taken not to injure the duodenum, the ureter, and the external iliac vein in this operation.

For growths of *the transverse colon* a free excision, with a deep V of the mesentery, should be performed ; then by mobilising the splenic flexure and descending colon (or possibly without this) it will be easy to join the ends together by side-to-side or end-to-end union. There is no objection to this latter procedure here, as the bowel is completely covered with peritoneum.

In the case of *the splenic flexure*, this, together with the whole of the descending colon, must be freely mobilised. The left half of the transverse colon, the flexure, and some inches of the descending colon, together with a deep V of the artificial mesentery, are excised. It is then preferable to restore the continuity of the bowel by side-to-side union, and this is usually possible if free mobilisation of the descending colon has been performed. The side-to-side union may be made deliberately anti-peristaltic, as this will turn the cut edges of the mesentery out into the retroperitoneal tissues, where they will not form adhesions to the rest of the bowel. In many cases the splenic lymphatic glands are invaded by growth, and these, of course, cannot be removed.

In the case of *the iliac colon*, again, very free mobilisation is necessary up to and including the splenic flexure. The iliac colon and most of the descending colon are removed and, if possible, a side-to-side union performed.

In the case of *the pelvic colon* many growths are inoperable, because of adhesions to the bladder or other pelvic structures. If the growth is freely movable and in the upper half of the bowel, it can be resected with some inches of bowel above and below it, and a deep V of the mesentery; end-to-end union may then be performed, as here again the bowel has a complete peritoneal covering. If the growth is lower down, it may still be removed and the continuity of the bowel restored by holding open the very short and fixed lower end and inserting the upper end into it and fixing it there with two rows of sutures; at times the top of the rectum may be mobilised and end-to-end suture performed. If the growth is lower still, right at the bottom of the pelvic colon, and is capable of removal, this must be done by the perineo-abdominal method (see p. 805). This will entail a permanent colostomy.

Fæcal Fistula. A fæcal fistula is an opening on the surface of the skin through which fæcal matter escapes and which has arisen as the result of disease. On the other hand, an **artificial anus** is a similar opening which has been specially made by the surgeon to permit of the escape of fæcal contents. The method of performing this will be described later, but it is important to note that in performing it, especially if it is intended to be permanent, some form of spur or projection outwards of the mesenteric wall of the bowel must be devised in order to prevent the fæcal stream passing onwards down the bowel, and to cause all the fæcal contents to escape externally.

In the case of a fæcal fistula the opening in the bowel wall is usually small, and may be some distance from the skin, while no spur is present, so that here, if there is no obstruction, only a portion of the fæcal contents escape.

There are many causes of fæcal fistulæ; thus at the umbilicus the condition may be congenital (see p. 529). They may be the result of injuries to the bowel, either accidental or operative, or occur as a result of sutures in the bowel wall giving way after anastomoses, etc. Sloughing of the bowel in a strangulated hernia is another cause. The pressure of drainage tubes left in place too long, the exposure of a coil of bowel in the bottom of an operation wound which has become infected and gaped open, or the proximity of abscesses and foreign bodies, which lead to infection and softening of the bowel wall, are all frequent causes, in that they give rise to ulceration and sloughing of the bowel wall. Appendix abscesses are particularly liable to be followed by this condition, and it must be admitted that the great majority of all fæcal fistulæ follow upon operations. Tuberculosis, actinomycosis and carcinoma of the bowel wall are also occasionally causes. If the bowel is adherent to the peritoneum the fistulous track is short, and the intestinal mucous membrane will appear at the skin or even pout out, though in other cases, possibly as the result of an abscess, there may be a long granulating, suppurating track intervening between the skin and the bowel wall.

Clinically the condition is usually obvious in that recognisable intestinal contents escape. In certain cases, however, abscesses infected with intestinal organisms, and especially those in fat people, may discharge profusely an evil-smelling, dark-brown pus, which may resemble fæcal matter.

The colour and consistency of the escaping fluid will depend on the part of the bowel it comes from. In the case of a small intestine fistula, digestion, redness and excoriation of the skin always occur. Fistulæ high up in the bowel (*i.e.*, in the jejunum) give rise to a discharge which is very fluid, acid, contains bile and undigested foodstuffs, and starts to discharge soon after a meal, while emaciation is very rapid; while if escaping from lower down, the fluid is alkaline, less irritating, more fæcal, and there is less emaciation. A cæcal fistula discharges definitely liquid fæces, while in the case of the rest of the colon the discharge is semisolid.

Treatment. The majority of these fistulæ will close spontaneously provided there is no obstruction in the bowel below, no concretion or foreign body present, and if the mucous membrane is not pouting out on the surface of the skin. If any of these conditions are present they must be removed.

Where the mucous membrane pouts out on the surface spontaneous closure is not likely, and an operation will be necessary. Two operations may be performed:—

(a) *Greig Smith's Operation.* Here the fistula is temporarily closed with a continuous suture, an elliptical incision is made round its mouth, and the various layers of the abdominal wall are incised until the peritoneum with the bowel attached to it is reached. The pouting mucous membrane is cut away, the bowel is not separated from the peritoneum, but the opening in the bowel wall and in the peritoneum is sutured and the abdominal wall then closed in layers over this.

(*b*) The only other alternative is a formal resection of the coil in which the opening is, followed by end-to-end suture. Owing to the presence of adhesions this usually can be performed without opening the general peritoneal cavity.

A lateral short-circuit above and below the fistula might be expected to cause it to close, but this frequently has no effect on the fæcal discharge.

If for any reason operation cannot be performed, or during the interval of waiting for it and hoping that the fistula may close spontaneously, the skin must be protected by an oily or greasy ointment; purgatives are to be avoided carefully, and the diet should be controlled to reduce the fæcal contents. The unpleasant odour may be much reduced by means of intestinal kerol, dymol or beta naphthol. Occasionally tight plugging will cure a fistula.

Internal Fistulæ. As a result of adhesions, carcinoma, gastric ulcer, diverticulitis, tuberculosis and other causes, fistulous tracks may form between the bowel and other hollow viscera; thus a fistula between the stomach and colon (gastrocolic fistula) is described on p. 627. Fistulæ between near-by loops of small intestine are symptomless. Openings are sometimes seen between the colon or rectum and the bladder, ureter or kidney pelvis; these are described in Chapters XIX. and XX. A fistula between the gall-bladder and duodenum is not uncommon in association with gall-stones (see p. 759).

INTESTINAL OBSTRUCTION

As the name implies, this condition consists in some form of blockage of the bowel so that the fæcal stream and intestinal gases cannot pass on in their normal course. Although the bowel may be simply blocked and the fæces obstructed, in a great many cases there is also interference with the nerves and the blood supply to and from the bowel wall and actual mechanical damage to the wall itself. This is known as *strangulation of the bowel*, and is an even more serious condition than obstruction. Obstruction can occur without strangulation, but strangulation hardly ever occurs without obstruction, except possibly in the case of a Richter's or Littré's hernia (see also p. 563). The distinction between constipation and obstruction lies in the fact that in the former there is delay in the passage of fæces only; there is no strangulation, no interference with the passage of flatus, and no mechanical block. It is better that the term "obstruction" should be confined to those conditions where a definite organic block of the bowel is present, *i.e., mechanical obstruction*. The same effect may be produced by lack of propelling power due to atony or paralysis of the bowel musculature, and though this is sometimes referred to as *dynamic or paralytic obstruction*, we prefer not to use the term "obstruction" in connection with this at all, but to give it the special name of *paralytic ileus* (see p. 696). It must be remembered that persistent and unrelieved organic obstruction also will lead in time to paralysis of the bowel wall, partly from overdistension and partly from peritoneal infection.

Three main varieties of obstruction will be encountered : acute obstruction, chronic obstruction, and an intermediate variety in which chronic obstruction is present and is gradually becoming acute. It necessarily follows that, if strangulation is present, the obstruction is acute, and that in chronic obstruction there is not likely to be any strangulation. As a result of stasis in the bowel, the small intestinal contents tend to become acid, and an overgrowth of B. welchii may occur (see pp. 532 and 538).

ACUTE INTESTINAL OBSTRUCTION

Pathological Changes. The changes in the bowel naturally depend upon the cause of the obstruction, but many of them are common to all varieties. If no strangulation is present, the bowel above the obstruction gradually becomes more and more distended by gas and liquid fæces, until finally it may reach two or three times its proper size. Violent peristaltic waves occur both above and below the block, so that the lower bowel empties itself and usually remains emptied and collapsed ; it is then pale and firm. Above the obstruction the wall of the bowel is first pale and normal looking, but it soon becomes crimson, congested, œdematous and darker in colour. Congestion and change of colour, however, do not occur nearly so rapidly when strangulation is absent, and bowel which is only obstructed may become red, but never purple or black. Fluid collects in this distended bowel and venous stasis occurs ; thus a vicious circle is set up and much serum is removed from the circulation, with the result that deprivation of volume of blood causes collapse, while loss of salts causes acidosis and aggravates vomiting ; hence the value of saline infusion in all cases of intestinal obstruction or peritonitis. After a time an effusion of fluid occurs into the peritoneal cavity, which is usually clear and watery if no strangulation is present. The peritoneal surface also becomes damaged, so that organisms can pass through the bowel wall and peritonitis occur without actual perforation. Actual ulceration of the bowel wall, with perforation, also may follow (stercoral ulcers, see p. 672).

This marked difference in the appearance of the bowel above and below an obstruction is of great help during operative treatment, as by following the lower portion up, or the upper portion down, the seat of obstruction is bound to be discovered.

The thickened œdematous congested bowel at or above the site of an obstruction is abnormally soft, holds sutures very badly, and may be torn very easily during operation if not very carefully handled.

If in addition strangulation is present, all the changes are much more rapid and marked, the bowel rapidly becoming congested, purple or black, while the effusion into the peritoneum is blood-stained, and dark blood is also found in the bowel lumen. Peritonitis or gangrene may be set up rapidly, and the changes in the bowel wall are more fully described on p. 531.

Causes of Obstruction. The causes of acute obstruction are many, and are usually divided into :—

(*a*) Conditions lying outside the bowel.

(*b*) Conditions in the bowel wall.

(*c*) Conditions inside the bowel.

(*a*) *Conditions outside the Bowel.* Pressure by tumours, cysts, etc., strangulation by bands and adhesions, or through openings or apertures in the mesentery, strangulated external herniæ and internal herniæ.

(*b*) *Causes in the Bowel Wall.* Growths, volvulus, acute intussusception, enterospasm, thrombosis or embolism of mesenteric vessels, fibrous stricture, diverticulitis, congenital malformations.

(*c*) *Causes within the Bowel.* Impaction of gall-stones or foreign bodies.

The causes of paralytic ileus will be discussed later (p. 696).

Clinical Features. We shall now describe the features of acute obstruction in general, and later indicate the differences which may occur according to the cause of the condition. It should be remembered that there are three main groups of signs and symptoms : those due to the actual blockage of the bowel, namely pain, vomiting, distension, constipation and increased peristalsis; those due to the shock to the nervous system and collapse, as a result of the sudden violent trauma the bowel and its mesentery may have undergone, *i.e.*, pallor, sweating, etc.; and finally those due to the absorption of toxic material accumulating in the bowel above the block and aided by peritonitis and damage to the bowel wall; this last group is naturally a comparatively late development, but its importance lies in the fact that in many cases it is the actual cause of death (Chapter XIII., pp. 532, 535).

The symptoms closely resemble those of strangulated external hernia, and commence with sudden pain in the neighbourhood of the umbilicus ; this is usually generalised all over the abdomen, and may be griping or seldom continuous, and cause the patient to cry out, writhe about, or crawl on the floor. If colicky and intermittent, after a time its colicky nature departs, and the pain becomes continuous, while as the patient gets worse and more toxic and the condition of the bowel wall begins to suffer, the pain tends to get less. Pressure usually will relieve it, while abdominal rigidity is absent.

Vomiting commences almost at once, becomes continuous, is accompanied with nausea and gives no relief. At first it consists of stomach contents, and is projectile in character ; later it is green and bilious, and as the condition progresses it becomes dark in colour, brown and evil-smelling, gushing up in an effortless and more or less continuous fashion. This is sometimes known as fæcal vomiting, though except for its evil smell it in no way resembles fæcal material. It is due to the decomposition of intestinal contents above the obstruction, accompanied by the onset of peritonitis and paralysis of the bowel wall, and should be regarded as a sign of impending death. It is most marked in small intestine obstruction, especially when high up, and is seldom seen when the colon is obstructed until the very latest stages.

Constipation is usually absolute, not even flatus being passed, though it is not uncommon for one motion to come away soon after the commencement owing to the lower bowel emptying itself ; enemata will have no effect, and purgatives, above all, should be avoided.

At the commencement a varying degree of collapse will be present, depending on the cause and the rapidity of onset, so that the pulse is thin and weak and often slow at first ; the temperature is subnormal, and the face pale and sweating. After a few hours the pulse rate begins to rise, and gets more and more rapid as the condition progresses. The temperature does not, however, rise for a considerable time, and not at all unless infection sets in. It frequently remains subnormal throughout. The patient becomes intensely dehydrated due to failure of the normal fluid and salt intake from the intestine (which amounts to several litres in twenty-four hours), and the loss of fluid from vomiting; the tongue is therefore dry and the facies pinched, and collapse increases rapidly.

On examining the abdomen the most important characteristic is the presence of visible peristalsis and coils of bowel. Thus coils of bowel may be seen writhing about, the movements coinciding with increase of pain; this, if seen, is almost positive evidence of obstruction, except in very thin, elderly patients. After a time distension of the abdomen commences and progresses, the abdomen becoming more and more tympanitic. Slight diffuse tenderness may be present, but there is no rigidity until peritonitis sets in; occasionally rigidity is present over gangrenous bowel.

On auscultation greatly increased peristaltic sounds will be audible, a condition very different from the absolute silence that is present in peritonitis. In certain forms of obstruction a localised tumour may be palpable. Examination of the rectum and of the hernial orifices must never be omitted; small herniæ, especially if they are femoral, are easily missed in fat patients.

In some cases of acute obstruction, and still more in subacute obstruction, an X-ray photograph taken without any barium will show visible distended coils lying across the abdomen with pools of fluid in them.

As the condition progresses the pulse rises, becomes rapid and feeble, thirst becomes intense, the eyes sunken, and the tongue very dirty, coated and brown, while soon the " facies Hippocratica " develops. Toxæmia will be marked, and the patient becomes blue or livid, cold and clammy; muscular cramps are especially marked, while his mind remains remarkably clear up to the end. If untreated, death supervenes within five or six days.

When the obstruction is in the *small bowel*, and the higher up it is, the shock, collapse and vomiting are more marked. Distension, however, is less marked, and is chiefly seen in the central portions of the abdomen. Visible coils are usually present, and assume a step-ladder pattern. In high-up obstruction anuria is sometimes seen.

In the *colon*, on the other hand, obstruction tends to be rather less acute, vomiting is often delayed for some hours, or even days, visible coils are very seldom seen, and the distension affects chiefly the epigastrium and flanks; in many cases a grossly distended cæcum can be seen or felt. The course of the disease is usually slower, due, probably, to the fact that normal fluid and salt absorption from the bowel is not interfered with.

It seems probable that the degree of distension, and also to a certain extent the amount of toxæmia, is very largely dependent on whether the mesentery is gravely involved or not.

Profuse fæcal vomiting tends to be more marked in children and nervous women than in men, while the pain tends to be more continuous when strangulation is present as well as obstruction.

Death, when it occurs, is frequently due to mere exhaustion; in other instances it is due to the onset of peritonitis, and is often the result of the general poisoning of the patient's whole system from absorption of the toxic bowel contents. In some cases this is due to B. welchii in the bowel (see p. 532). At times there seems to be a marked diminution of the chlorides in the blood together with an alkalosis. Chlorides and fluids are therefore indicated in the treatment.

Differential diagnosis has to be made from the other forms of acute abdominal disease (see Chapter XVII.), and also from colic of various kinds, gastric crises of tabes (see p. 730), and uræmia. The presence of a palpable tumour suggests as the cause of the obstruction either an intussusception, a growth, a gall-stone, or congested and œdematous bowel which is strangulated by bands or internal herniæ.

Treatment. Though the necessity to relieve the obstruction is great, the call for replacement of salts and fluid in the tissues is very pressing, and in most cases the administration of saline solution, both intravenously and subcutaneously, should be carried out before operating, when a marked improvement in the general condition will result, vomiting diminish, and the prognosis be correspondingly improved. Furthermore the exhaustion and distress of frequent vomiting can be diminished and relief of pressure and distension in the bowel above the obstruction, with consequent improvement in its circulation and lessening of toxæmia from absorption of its contents, can be obtained by passing a nasal tube either into the stomach or duodenum (Wangensteen) or gradually letting it descend to the neighbourhood of the obstruction (Miller-Abbott), a process which can be aided at operation. A suction apparatus is attached to the upper end and the contents withdrawn continuously or at intervals ; care must be taken not to continue this treatment too long or the patient becomes unnecessarily dehydrated.

The local treatment consists in laparotomy, which should be performed as soon as possible. The procedure to be adopted then will depend entirely upon the cause of the obstruction, and will be described later ; but the surgeon should always have two objects in view : firstly, to remove the cause of the obstruction, and secondly, to empty the bowel above the obstruction. Rapidity in operation and gentle handling of the bowel are essential if success is to attend the efforts of the surgeon. There is some evidence that the intense toxæmia is diminished and the patient's chances increased by administration of B. welchii serum before and after operation. For the use of bile in cases of peritonitis and obstruction, see p. 538.

In general it may be remarked that one of the dangers of these operations consists in the patient vomiting while under the anæsthetic, and the vomit passing into the air passages, hence the value of preoperative duodenal suction, which can be continued as necessary during the operation. Some surgeons advise that the stomach should be washed out before the operation is commenced, but this is really of very little value and may lead to a false sense of security, as the stomach will fill again rapidly from the distended bowel. The only remedy for this is to leave the tube in situ all the while the anæsthetic is being administered. It is important not to have the patient's head too low and not to compress or squeeze the stomach, if possible, during the laparotomy.

In these cases, unless the patient is very collapsed, spinal anæsthesia is excellent as it gives good relaxation of the abdominal wall, and often actually helps to relieve the obstruction by diminishing any bowel spasm.

Unless the site of the obstruction is settled it is best to open the abdomen by means of a right paramedian, infraumbilical incision. It must be remembered that the distended coils of bowel are very friable, and care must be taken not to allow coils of distended bowel to escape. The cæcum is then examined. If it is distended, the obstruction is in the colon ; if contracted, it is the small bowel which is obstructed, and any contracted coil of intestine which is seen is carefully followed up until the obstruction is met with.

It should be remembered that the majority of causes of obstruction lie in the right iliac fossa or the pelvis, while if great difficulty is experienced in finding the obstruction it may be justifiable to allow some coils of bowel to escape into hot towels, but it is not advisable. The obstruction is then removed, the method of doing this depending on its nature and its cause. If the patient's condition is bad and the bowel very distended, it is best to insert a tube into the jejunum and perform a jejunostomy, which will remain open for a week or two, as this offers the best chance of getting rid of toxic bowel contents. In some cases, where the patient is desperately ill or the obstruction cannot be found, a jejunostomy should be performed to tide him over a few days, and the obstruction can be sought for and removed at a later date.

Further details in the treatment of special forms of obstruction will be found on pp. 685–696.

CHRONIC INTESTINAL OBSTRUCTION

This is the result of a gradually increasing interference with the passage of the intestinal contents, or of an incomplete block, and is usually due either to impaction of fæcal masses or foreign bodies, adhesions, chronic intussusception, growths, fibrous strictures of the bowel wall, pressure by abdominal tumours, or Hirschsprung's disease (see p. 654). The colon is the part of the bowel most commonly affected, and growths are the most common cause. There is no strangulation, and no shock or collapse.

Pathological Changes. Here none of the changes characteristic of acute obstruction, namely, congestion, change of colour, or œdema of the bowel, are present. The bowel above the obstruction will be distended, but its muscular walls will be greatly hypertrophied and thickened; the distension is usually most marked in the colon, the hypertrophy in the small intestine, and the colon in particular may become enormously enlarged. When the condition is much advanced, catarrhal inflammation of the mucous membrane with stercoral ulcers will be seen, and the result of the gross distension of the bowel is that it separates and passes down between the two layers of the mesentery; thus this structure appears to be shortened and the bowel tied down.

Clinical Features. This condition comes on insidiously and progresses very slowly, the first symptom usually being a gradually increasing constipation. This occasionally alternates with attacks of so-called diarrhœa, which are the result chiefly of irritation and infection of the bowel wall. Flatulence and distension will be complained of, and after a time discomfort and abdominal pain, especially after meals. Occasional attacks of vomiting will occur and the patient's health gradually fails, while he himself often describes his condition as "indigestion." Small, temporary, severe attacks of more or less acute obstruction, which pass off spontaneously, are occasionally seen, and the symptoms gradually progress until even purgatives fail. When the disease is in the colon, the passage of mucus and wind is frequently noticed by the patient, and he may refer to it as diarrhœa. Frequently he complains much of loud gurgling noises, and this is a very characteristic symptom.

On examination of the abdomen a certain amount of distension will be found, while usually there will be marked visible peristaltic waves, giving rise to a "step-ladder" pattern. The nature and shape of the distension depend upon the site of the obstruction, as described on p. 679. Distended large bowel can often be seen, but it is not often noticed to move, while on palpation the coils of bowel can be felt to become hard when the colicky pain occurs. As in the case of acute obstruction, examination of the rectum must never be omitted ; it often will be found to be ballooned, and with its mucous membrane smooth instead of rugose. On auscultation extra loud peristaltic sounds will be heard. X-ray examination reveals a characteristic ladder pattern of the distended coils of small bowel (see p. 679).

As the condition progresses the patient loses weight, becomes toxic and sallow, with foul breath and dirty tongue. If untreated death will sooner or later occur, either from the onset of acute obstruction, from perforative peritonitis, or from sheer exhaustion. When the obstruction is due to carcinoma of the colon, the tongue is often remarkably clean.

The diagnosis of the condition is obvious, but the cause may be obscure. In children it is most likely to be due to tuberculous peritonitis or appendicitis which has produced adhesions, or Hirschsprung's disease ; in the adult, to adhesions, fibrous stricture, the pressure of tumours, diverticulitis, hyperplastic tuberculosis or malignant disease, and in the elderly to chronic intussusception or malignant disease.

Treatment. In mild and early cases this should be the treatment of the causal condition, but in most cases operation will have to be undertaken, and this should not be left too long. The cause of the obstruction should then be removed if possible. In some cases this will not be practicable, and then either a short circuit or a colostomy may be required according to circumstances (see pp. 698–703).

CHRONIC OBSTRUCTION BECOMING ACUTE

The third type of case which is not uncommonly seen is one in which chronic obstruction exists for some weeks or months, and then finally more or less suddenly the block becomes complete and the obstruction acute. The cause is usually a slowly progressive lesion which produces more and more stenosis of the bowel until after a time a sudden impaction of fæcal material occurs, which may be aided by congestion of the bowel wall due to tympanites and distension by gas or possibly by the use of purgatives. The majority of these cases are due to a growth in the colon, and acute or complete obstruction may set in after some weeks' or months' history pointing to chronic obstruction. Complete obstruction, when it sets in, is not as a rule desperately acute, and its treatment will depend upon its cause and situation.

VARIETIES OF ACUTE OBSTRUCTION

We shall now proceed to consider the different types of obstruction according to their causes. The following remarks on the diagnosis and methods of examination may be taken to apply to all (see also pp. 721, 722), as also the methods of treatment described on p. 680.

Acute obstruction is an urgent condition in which every hour saved in undertaking surgical treatment is of value, while the diagnosis should be made as early as possible. We cannot insist too strongly upon the danger in this condition of giving :—

(*a*) Purgatives, which increase the pain and vomiting, exhaust the patient, and may lead to perforation of the bowel.

(*b*) Morphia and opium derivatives, until a certain diagnosis is made and the line of treatment settled, as they may completely mask the symptoms.

There is never any objection to giving an enema ; this sometimes will empty the lower bowel, lessen distension, and by its failure to produce any result, assist in the diagnosis. Two enemata at an hour's interval are often valuable ; if the second produces no result obstruction is probably present

Infusion of saline or its administration subcutaneously to replace fluids and chlorides lost from the tissues, should be carried out in all cases as a preliminary to operation.

In the history and abdominal examination the points referred to in Chapter XVII. must be noted carefully, but in connection with obstruction in particular, and with regard to the history, special attention should be paid to whether the patient has suffered from any previous condition which might give rise to adhesions, such as an operation, appendicitis, peritonitis, tuberculous or otherwise, and also whether there is any history pointing to increasing constipation, gall-stones, or dysentery.

With regard to the examination of the patient, the special points to which we wish to call attention are firstly the presence of peristalsis or visible coils of bowel, secondly the lack of temperature and rigidity, thirdly the nature of the pain, which is usually intermittent and colicky if the obstruction is incomplete, but tends to be continuous when obstruction is complete and when strangulation is present; finally the importance of auscultating the abdomen to discover whether peristaltic sounds are increased or diminished. If only a single distended coil can be seen writhing about it is probably close to the site of the obstruction ; great attention should be paid to examination of the hernial orifices and of the rectum.

With regard to the age incidence of the various forms of obstruction, it should be noted that the commonest forms of obstruction are :—

(*a*) *In the infant:* intussusception, strangulated hernia, or congenital deformities of the bowel and rectum.

(*b*) *In a child:* intussusception, strangulation by bands or Meckel's diverticulum, strangulated hernia, usually inguinal.

(*c*) *In an adult:* strangulated hernia, strangulation by bands or adhesions, volvulus, and malignant growths.

(*d*) *In the elderly:* strangulated hernia, malignant disease, or intussusception.

STRANGULATION BY BANDS, ADHESIONS AND MESENTERIC OPENINGS

This is one of the commonest forms of obstruction, accounting for 70 per cent. of cases, the bands and adhesions met with being of very different varieties.

(*a*) The common variety of peritoneal adhesions or bands follows upon various forms of irritation and infection of the peritoneum. Thus they follow peritonitis of all kinds, operations, inflammation of various organs within the peritoneum, and may be due to many other causes (see also p. 557). They may be localised narrow cord-like structures, or may form broad ligaments or sheets ; they may be single or multiple, and it is probable that the continual intestinal movements tend to mould them and roll them up into cord-like form. They frequently pass from the mesentery to some other organ, and are specially found either in the right iliac fossa, the pelvis, near to hernial openings, or in the epigastrium. Very widespread adhesions will exist often for years without causing any symptoms at all, though in other instances they may give rise to such symptoms as colicky pain and vomiting with increasing constipation (see p. 681). A single adhesion is more likely to cause trouble than widespread ones.

(*b*) Various viscera sometimes form bands or act like bands in producing strangulation of the bowel; thus a portion of tough omentum adherent at its end, and thickened and fibrosed by recurrent attacks of inflammation, may act in this way. Such an omental band is particularly liable to be attached at one end to the appendix or the Fallopian tube.

The appendix itself, appendices epiploicæ or occasionally even the Fallopian tubes may become adherent at one end to other structures, and in this way constitute a band which will produce acute obstruction, while even coils of bowel have contracted such adhesions that the coil itself is in a position to strangulate some other part of the bowel.

(*c*) Meckel's diverticulum is particularly liable to give rise to strangulation, as it forms a tense round band traversing some part of the abdomen.

(*d*) Abnormal openings in various abdominal structures are occasionally seen These are found chiefly in the omentum or the mesentery; in some cases they are congenital, and in others the result of previous trauma or operations. Smooth, round holes are sometimes seen in the mesentery of the lower ileum (*mesenteric hernia*), and other coils of bowel passing through this opening are liable to become strangulated. When this occurs it must be remembered that not only are the coils which have passed through the opening liable to become gangrenous, but their pressure may cut off the blood supply of that coil in whose mesentery the opening is, so that it also becomes gangrenous itself.

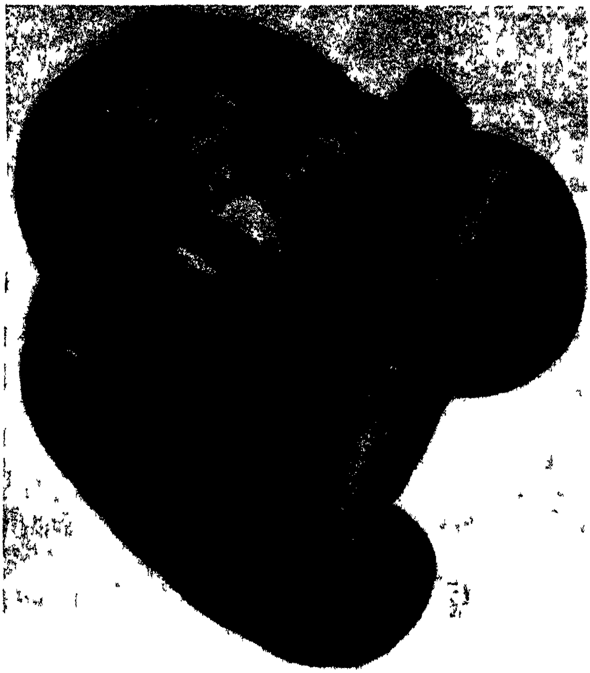


FIG 246. Strangulation of the small bowel by a band.

Bands of this kind may produce strangulation in two ways. If the band is attached at both ends, a coil of bowel may pass under it or over it and thus become twisted or constricted, while if the band is long and unattached at one end it may form a loop or noose by means of which the bowel may become ensnared.

Clinical Features. Though in some cases the bands or adhesions above described will give rise to well-marked symptoms of chronic obstruction, acute obstruction with actual strangulation is more common, and of course far more serious. Obstruction due to this cause is very common, usually occurs in people under forty, generally involves the lower six feet of the ileum, and is of a very urgent and serious type, as tight strangulation is usually present as well as obstruction. There may be a previous history suggesting a cause for the bands, or the scar of an abdominal operation may be present. The onset is very sudden ; all symptoms are severe, collapse is marked, and the features are usually those of a small intestine obstruction, as it is very rare for the colon to be obstructed by adhesions. No tumour can be felt usually unless the bowel is very œdematous or gangrenous while the distension is general. Gangrene of a complete coil or of a patch along the constriction groove is likely to set in early.

Treatment. This consists in a laparotomy performed as soon as possible after suitable administration of fluids, and relief of the bowel distension (see p. 680). On opening the abdomen watery fluid will escape, which, if the strangulation is severe, will be blood-stained. In most cases the cause of obstruction is sought for, and if it is an ordinary band it must be ligatured at both ends and cut away, so as to free the bowel. A Meckel's diverticulum or appendix causing obstruction should be removed, but care must be taken in the haphazard cutting of bands, as it should be remembered that they may consist of one or more tightly twisted and collapsed coils of bowel. We know of one surgeon, who on cutting what he thought to be a thick, fleshy band in the abdomen, then discovered six open bowel ends, the apparent band having consisted of three collapsed and tightly twisted coils of bowel.

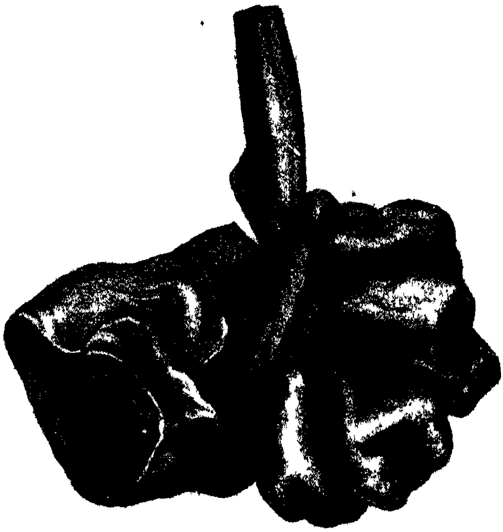


FIG. 247. Strangulation of the small bowel by Meckel's diverticulum.

In a few cases the adhesions cannot be unravelled or the bowel set free. In this case either resection of the affected segment or a short-circuit above and below it must be performed, according to circumstances. If the bowel is gangrenous, resection, of course, will be necessary, and in most cases in the small intestine we prefer to perform an end-to-end union. A few cases will be so desperate that an artificial temporary anus is the only course, but this is to be avoided if possible.

After a band has been cut and the bowel set free, the possibility that other bands are present and also causing constriction should be remembered, and they should be looked for.

After cutting a band and setting free a coil of bowel, a careful inspection must be made of the constriction groove where the bowel was snared, as early gangrene, ulceration or perforation may have occurred here. In this case the groove can be invaginated or the bowel resected. If the bowel is grossly distended or congested it may be wise to empty the greater part of it before the abdomen is closed. This can be done by making a small opening in it, passing in a Moynihan's tube and threading some feet of the bowel over this tube, so that the contents are conducted away, care being taken that none of them escape at the side of the tube: the opening in the bowel is then closed. Alternatively a previously inserted Miller-Abbott tube can be guided down the bowel to just above the obstruction and the contents removed by suction.

After-treatment. The urgent indications in after-treatment are :—

(*a*) To provide the patient with fluids ;

(*b*) To prevent his bowel from becoming paralysed and to encourage it to act ; and

(*c*) To encourage the elimination of toxins.

Thus he should be propped up in bed in the Fowler position, and be given rectal saline either during or immediately after the operation. For the first twelve hours he should have only an ounce of fluid by the mouth per hour, but after this his diet may be gradually increased ; there is no objection to morphia to relieve pain, but large doses of aspirin and bromide in the rectal saline will probably act just as well. After twenty-four hours an effort may be made to get the bowel to expel flatus ; pituitary extract, 1 c.c. twice a day, and eserine $\frac{1}{100}$ grain, four-hourly, aided by a turpentine enema once a day, are invaluable for this purpose. As long as the patient is vomiting aperients must not be given, but as soon as this has ceased an aperient may be administered if necessary. This should consist either of castor oil, or calomel at night, followed by salts in the morning. If a resection has been performed aperients are better avoided for four or five days, but there is no objection to esserine, pituitary or enemata.

In serious cases where the vomiting persists, antigasgangrene serum and bile enemata are often of value (see p. 538).

The complications following operations for acute obstruction are the same as those which may follow any other abdominal operation, though there is a special liability to pneumonia and paralytic ileus (see p. 696).

STRANGULATED INTERNAL HERNIA

This is a rare form of acute obstruction, though there are several localities in the abdomen where such a hernia may occur.

Retroperitoneal Herniæ. A hernia occasionally occurs in certain pouches or fossæ in the retroperitoneal tissues, and these fossæ are seen in three situations :—

(*a*) *In the Neighbourhood of the Duodenojejunal Flexure.* Three fossæ have been described here: a paraduodenal fossa and a superior and inferior duodenojejunal fossa. For ordinary purposes, however, two types of hernia only are seen here, the *left duodenal hernia,* which passes down and to the left of the transverse colon, and the *right duodenal hernia,* which passes down to the right towards the ascending colon. Strangulation is usually caused at the neck of the fossa, the border of which in the case of the left duodenal hernia contains the inferior mesenteric vein, and in the case of the right duodenal hernia, the superior mesenteric artery.

Though these herniæ may give rise to indigestion, colicky pain and constipation, they are never diagnosed until obstruction is present, and even then only on opening the abdomen. When obstruction has set in all the signs of a moderately severe acute obstruction are present, and they are suggestive of obstruction high up in the jejunum, so that shock and vomiting are marked. A resonant, rounded, ill-defined swelling usually can be felt in the neighbourhood of the duodenum, while it is said that bleeding piles may occur as the result of pressure on the inferior mesenteric vein. There is frequently a previous history of similar less severe attacks in which the obstruction has relieved itself. A very large number of coils of small intestine are sometimes present in the hernia.

Treatment. This consists in laparotomy, and when the condition is discovered the strangulated bowel, if possible, must be withdrawn without cutting the neck of the sac, as the inferior mesenteric vein or superior mesenteric artery would be in danger. This may be assisted by opening a coil of the strangulated bowel and emptying it, to relieve the distension. Gangrene is not often seen. When the bowel has been reduced the neck of the fossa should be closed with sutures, to prevent any recurrence.

(*b*) *In the Neighbourhood of the Cæcum.* Three retroperitoneal fossæ are described here by anatomists ; but when a strangulated internal hernia occurs at this site it is usually impossible to say which variety it is. Strangulated coils are usually found passing up behind the cæcum and ascending colon, and the symptoms are those of a not very severe degree of acute obstruction of the small bowel, together with a tympanitic, ill-defined, rounded, tender swelling in the right iliac fossa. The treatment consists in operation as soon as possible, when, with a little stretching of the neck of the sac, the hernial contents can usually be withdrawn, as the strangulation is not generally very tight. The opening should then be obliterated and the appendix removed if necessary.

(*c*) *In the Mesentery of the Pelvic Colon.* This is the rarest variety, though an internal hernia is occasionally seen here, passing between the layers of the mesentery of the pelvic colon. The signs and symptoms of an obstruction here are similar to those described above, save that the tender swelling is in the left iliac fossa. Relief should be given at once by means of operation, and great care must be taken in cutting or stretching the constriction, as important sigmoid vessels may run in its neighbourhood.

Hernia into the Foramen of Winslow. This is again an exceedingly rare condition, and not likely to occur if the foramen is of a normal size. Coils of small intestine may pass through into the lesser sac, and we have seen an abnormally mobile cæcum do this.

Another rare form of obstruction in this neighbourhood is a strangulation which may occur through the opening made in the transverse mesocolon when the operation of posterior gastroenterostomy is performed (see p. 642), and great care, therefore, should be taken, when performing this operation, to see that this opening is properly sutured. We have also seen a strangulation of the small bowel occur between the loops of a gastroenterostomy en Y.

The signs and symptoms in this condition are again those of acute obstruction of the small bowel, together with an ill-defined, tender, resonant epigastric swelling.

These last forms of obstruction are very acute, more so than the ordinary internal hernia. In most of them, and especially in the case of the foramen of Winslow, it is impossible to cut the constricting structures, and thus usually the lesser sac will have to be opened and the distended bowel emptied first; it should then be possible to reduce it. It is well to conclude the operation by closing the aperture through which the strangulation has occurred, if possible.

Strangulated Obturator Hernia. See p. 608.

VOLVULUS

This is a very severe and acute form of obstruction, in which a coil of bowel is twisted upon its mesenteric axis, *i.e.*, an axis lying in the mesentery and at right angles to the length of the bowel. Thus, not only is obstruction present, but a considerable portion of the blood supply of the intestine is interfered with while the obstructed coil is blocked at both ends. Very occasionally a compound volvulus is seen in which two coils of bowel are twisted and intertwined with each other. The condition occurs most commonly in the pelvic colon, and is occasionally seen in the cæcum or small intestine. Volvulus of the gall-bladder and of the transverse colon has occasionally been described, and the appendix or a Meckel's diverticulum may be similarly affected.

(*a*) **Volvulus of the Pelvic Colon.** The pelvic colon consisting as it does of a loop shaped like a capital Omega, with its two limbs closely drawn together at the base, there are obvious possibilities of a twist occurring around this narrow pedicle. The liability to this will be increased if the loop of bowel is long and overloaded, if its two ends at the base are closely approximated, or if the mesocolon is long; thus constipation, previous inflammatory attacks causing contraction of the base of the mesentery, or abnormal adhesions are all predisposing causes. In chronic constipation an over-distended pelvic colon sometimes will fall down into the pelvis and become twisted as a result of irregular peristalsis or sudden muscular efforts, the upper half of the pelvic colon usually passing forwards and downwards, while any number of turns from a half to two or three complete turns may occur.

A complete obstruction of both ends of the loop occurs at once, while its blood supply in the root of the mesentery is grossly interfered with. The bowel wall becomes congested, œdematous, and hæmorrhagic; blood-stained fluid escapes into the peritoneum and into the bowel lumen, and gangrene soon sets in. The strangulation, together with the blockage of both ends of the loop, causes the coil to become rapidly and grossly distended with gas, so that the peritoneal coat may split, pressure gangrene may occur in patches, and the coil may appear to fill the abdomen. Plastic peritonitis soon fixes the coil, by means of adhesions, in its twisted position.

Clinical Features. This condition usually occurs in men between forty and sixty with a history of constipation; there is an urgent onset of grave and rapid symptoms of obstruction, pain and distension being very marked, while the pain and tenderness tend to be more marked in the left iliac fossa. No flatus is passed, though severe tenesmus is present. Vomiting is not a marked feature, nor is collapse, as the obstruction is in the colon; hiccough and belching are often prominent. The most marked feature is the rapidity and the amount of distension, especially on the left side of the abdomen, while it is sometimes possible to see or feel one enormous coil standing up. This may push up the diaphragm and cause dyspnœa and interference with the heart. Rigidity is sometimes present in this form of obstruction. If untreated, death from peritonitis or exhaustion will occur within five days.

Treatment. This consists in urgent laparotomy, which, if possible, should be done by means of a large incision over the distended coil. It is sometimes possible then to guide a flatus tube through the anus and up past the obstruction, so as to empty the distended loop, or it may be emptied by means of a small opening in its wall. If the bowel is viable, the volvulus must be untwisted, and the emptying of the loop above described will assist this greatly, while adhesions and gross distension will render the untwisting difficult. If it can be untwisted, the bowel should be returned to the abdomen, though in most cases it will be safer to make a temporary colostomy in the coil, utilising the opening already made for drainage ; this colostomy, of course, will need no spur.

At the end of the operation, if the patient is fit for it, it is always wise to endeavour to prevent a recurrence of the volvulus (which is by no means uncommon) by suturing or shortening the mesentery or fixing the coil in some way. The colostomy opening made for drainage probably does this satisfactorily. If recurrence does take place later, it will be wise at some time to remove the pelvic colon. If gangrenous the coil will have to be resected, and if this is so it is wiser to insert Paul's tubes into both open ends and not attempt a union of the bowel until a later date.

The after-treatment of this operation is similar to that described on p. 686. Volvulus is a condition with a very high mortality.

(*b*) **Volvulus of the Cæcum.** This only occurs when the cæcum and ascending colon have a very long mesentery, and the causes and pathological changes are the same as those already described. The condition is less acute than volvulus of the pelvic colon, gangrene is rare, and the symptoms are those of a moderately severe acute obstruction, while the tender, resonant, distended cæcum can be felt. In many cases the cause of the obstruction will not be diagnosed.

The treatment consists in laparotomy as soon as possible, and, if it is feasible, the cæcum is untwisted and sutured into place to prevent recurrence ; while if the distension is great a temporary cæcostomy will be a wise precaution. In some cases a formal resection of the cæcum should be performed some weeks later, as otherwise a recurrence is more than possible.

(*c*) **Volvulus of the Small Intestine** is not very common, and when it occurs it is nearly always associated with the presence of bands or adhesions, which are responsible for the twist in the bowel either by fixing it so that it rotates round itself, or by a coil of bowel falling over the band and twisting round it. In many cases, even when the abdomen is opened, it is impossible to say whether the condition is really a volvulus round the band or a snaring of the bowel by the band. One or more coils of small bowel are nearly always affected, while occasionally in small children almost the whole ileum has rotated and become gangrenous.

This is an exceedingly acute and grave form of obstruction, and gives rise to very severe symptoms of small intestine strangulation, shock, collapse, pain and vomiting being marked, while it is by no means uncommon to be able to feel the strangulated and swollen coil as a palpable mass ; gangrene sets in very early.

The *treatment* consists in instant laparotomy ; the abdomen will be found full of blood-stained fluid, and the twisted coils are easily felt and discovered. Bands must be cut and the twisted coils either untwisted or resected according to their viability. In this latter case the resection should be followed by immediate end-to-end suture.

IMPACTED GALL-STONE OR FOREIGN BODY

The foreign bodies which are liable to give rise to obstruction are :—

(*a*) Bodies which have been swallowed (see p. 657), and Murphy's button, when used.

(*b*) Enteroliths (see p. 657).

(*c*) Gall-stones.

A **gall-stone** which becomes impacted in the small intestine and gives rise to obstruction is usually at least an inch in diameter. It, therefore, cannot have come down the bile-duct, but must have reached the bowel by means of a direct fistulous communication between the gall-bladder and duodenum. As the lumen of the ileum continuously decreases towards its lower end, the impaction usually occurs in the lowest three feet, and is undoubtedly aided by spasm of the intestinal musculature. This condition is one of pure obstruction without strangulation, though it must be remembered that ulceration and infection of the bowel wall will occur very likely at the site of impaction, from pressure.

Clinical Features. This condition is usually seen in stout women over fifty who have suffered from gall-stones for years, and their symptoms have usually been those of large gall-stones rather than small ones, *i.e.*, flatulent indigestion and inflammatory attacks in the neighbourhood of the gall-bladder rather than biliary colic or jaundice. There may have been an exacerbation recently due to local peritonitis and the formation of a fistula between the gall-bladder and duodenum ; cases have been seen, however, in which no previous history pointing to gall-stones can be obtained.

When acute obstruction occurs the symptoms are those of a moderately acute small intestine blockage, though, there being no strangulation, shock and collapse are little marked ; vomiting is marked and profuse, and it frequently happens that the symptoms supervene upon the taking of a purgative. Women of this type are notoriously costive, and it is possible that the purgative actually precipitates the displacement of the gall-stone into the duodenum, while it may happen that even after obstruction has occurred the purgative may act once or twice, and thus complicate the diagnosis. It is sometimes possible to feel the stone as a hard rounded tumour, either from the abdomen or the rectum. There is a distinct tendency for the symptoms suddenly to abate or disappear for a few hours, once or twice, and this is probably due to the stone moving on down the bowel before becoming finally impacted.

The diagnosis of this condition is, however, complicated by the fact that usually both the patient and her medical attendant regard the condition as another of her acute attacks of abdominal pain to which she has frequently been subject in the past, and the differences which are really characteristic of acute obstruction are not at first observed. Thus delay in treatment occurs, and this form of obstruction has a particularly high mortality.

Treatment. This again consists in operation as soon as possible. By tracing up the contracted ileum from the cæcum, the gall-stone is discovered rapidly ; the obstructed loop is then withdrawn, and the gall-stone pushed up for some inches, as it is not wise to open the bowel wall at a place where ulceration and infection have occurred from the pressure of the stone.

A clamp is then put on above and below the stone, the coil carefully packed off with gauze pads, a longitudinal incision made over the stone, and the stone removed. The incision in the bowel is then closed transversely with two layers of continuous sutures, the first through and through all coats, the second of the inverting Lembert type. The abdomen is closed without drainage.

INTUSSUSCEPTION

This is a serious and common form of obstruction in which one portion of the bowel wall becomes invaginated into the adjoining part, nearly always that part immediately below it. A few instances of retrograde intussusception have occasionally been seen in the post-mortem room, where a portion of bowel has prolapsed into the bowel above it, but it is thought that this usually only occurs during the death throes. We have, however, encountered one such retrograde intussusception in the ileum of a living patient.

The portion of bowel invaginated is known as the *intussusceptum*, and the lowest portion of this intussusceptum, *i.e.*, the most advanced part of the invaginated portion, is known as the *apex*. The bowel into which this invagination passes is known as the *intussuscipiens*. It will be seen, therefore, that the intussusception consists of three layers of bowel, an inner entering tube, a middle or returning layer, and an outer or ensheathing layer, the latter two layers forming the intussuscipiens. The apex is nearly always the starting point of the intussusception, and usually remains constant, passing lower and lower down the bowel and dragging behind it and into the intussuscipiens more and more bowel; thus the intussusception increases in size at the expense of the ensheathing layers. As the bowel enters the intussusception, its mesentery will be dragged in too, the actual point of entry of bowel and mesentery being called the *neck*, and as the condition increases this entering mesentery will become compressed and constricted, so that the blood supply of the intussusceptum is cut off, the veins being affected first.

An intussusception therefore forms a firm, elongated, sausage-shaped tumour, while the presence of the mesentery causes this tumour to bend into a curved shape, and the closely-packed mesentery will be found entering the neck of the intussusception on the concave side. The contraction of the mesentery tends also to fix or anchor the tumour. Interference with the venous return causes the intussusceptum to become congested and œdematous; it swells, and this together with the constriction at the neck, and adhesions between the various layers caused by a plastic peritonitis which is soon set up, soon render the return of the intussusceptum impossible, and the condition becomes *irreducible*. Both obstruction and strangulation are present, so that after a time gangrene will set in, this affecting chiefly the intussusceptum; in fact a few instances have occurred in which the intussusceptum has become gangrenous and sloughed completely, being passed as a slough per rectum. The entering and ensheathing layers having become adherent at the neck, this has occasionally been followed by spontaneous recovery. In other instances peritonitis has occurred without gangrene, either by organisms passing through the bowel wall, or from the formation of stercoral ulcers. Another result of the venous congestion is that blood and mucus exude from the bowel wall into its lumen.

An intussusception may be acute or chronic, and the foregoing is an account of the pathological changes in the acute condition. In the chronic type obstruction of a chronic variety is present, but the interference with the blood supply of the bowel wall is not marked. Gangrene does not therefore occur, and the condition may last for weeks or months, ultimately becoming irreducible as a result of adhesions due to plastic peritonitis.

With regard to the cause of intussusception, there is little doubt that it is the result of irregular and violent intestinal peristalsis, however set up. This may be due to enteritis or diarrhœa and vomiting, to polypoid tumours of the bowel, such as adenomata, sarcomata, to Meckel's diverticulum, to carcinoma of the colon, to worms, to enlarged and swollen Peyer's patches, or enlarged lymphatic glands, or to the presence of hard fæcal masses or foreign bodies. In a few instances, blows, injuries or falls seem to have caused the condition. It is particularly common around Christmas time.

Varieties of Intussusception. The condition is classified according to the portion of the bowel involved, and we meet with :—

(*a*) *Enteric Intussusception.* This involves only the small intestine, is usually seen in children between the ages of three and ten, and is generally the result of an intestinal polyp or Meckel's diverticulum. It is the second commonest variety, and strangulation is generally very tight.

(*b*) *Colic Intussusception.* This is confined to the large bowel, is the rarest kind, is usually seen in adults, and commonly associated with a carcinoma of the colon. It is generally of a chronic type.

(*c*) *Enterocolic Intussusception.* This is by far the commonest variety, both small and large bowels being involved. It is the acute type and usually occurs in children under two years old. It may further be subdivided into two groups :—

(1) *The ileocæcal* variety, in which the ileocæcal valve forms the apex and passes down the colon, dragging with it the first part of the ileum and then the cæcum, appendix and ascending colon. The effect of this sometimes is to give the appearance of an invagination within an invagination on reduction. This is the commonest type ; it may reach a very large size, the ileocæcal valve passing down until it reaches the rectum or even protrudes through the anus.

(2) *The ileocolic* variety, which is less common. Here the last few inches of ileum first of all pass through the ileocæcal valve. After a time this valve follows and enters the cæcum, and the cæcum and ascending colon then follow suit. This is the only variety of intussusception in which the apex does not remain constant, as here, at first, ileal coils pass through the fixed ileocæcal valve.

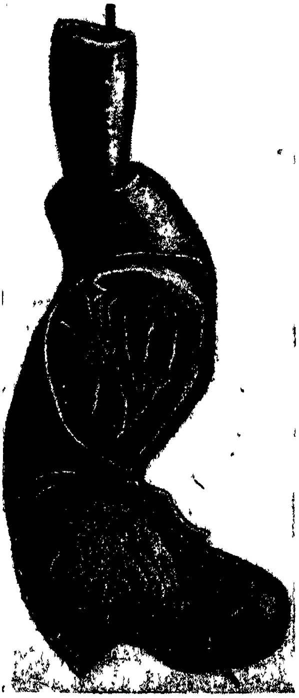


FIG. 248. Intussusception of the small bowel.

Very rarely multiple intussusceptions are found. The fact that the colon is larger than the ileum and that the mesocolon in infants is long, enable intussusceptions in infants to be much bigger than in adults and to involve a much greater length of bowel ; moreover, the strangulation tends to be rather less tight.

Acute Intussusception. *Clinical Features.* This variety almost always occurs in babies under two years old, more commonly boys, and usually fat, fine, flourishing children, seventy-five per cent. of whom are under one year old; usually the age is from seven to ten months, while it is far more common in hospital than private patients. Sometimes there is a few days' history of enteritis with diarrhœa and vomiting, but often the onset is sudden, the child commencing to have screaming attacks at intervals of a few minutes during which it appears to have severe intestinal colic, drawing its knees up and going pale. These attacks go on at recurring intervals, and after a short time vomiting sets in; this, however, is not severe or persistent, and is never fæcal. The child soon becomes pale, collapsed, and looks ill, though in the intervals free from pain its appearance improves greatly. The bowels occasionally will act once or twice normally, but within a few hours frequent small quantities of blood-stained mucus are passed, often accompanied by tenesmus. These motions may resemble prune juice in appearance and contain no fæcal matter. The intervals between the attacks of pain get shorter and shorter, and in the course of twelve hours or so the child goes rapidly downhill.

On examining the abdomen, distension is rarely present except towards the end, and visible peristalsis or coils cannot be seen; there is also little tenderness. In nearly every case, if properly sought for, a tumour will be felt; this is firm and sausage-shaped, may be curved, and may lie either in the right hypochondrium, the right iliac fossa or in the line of the transverse or descending colon. It is usually slightly movable and can at intervals be felt to harden under the fingers, this coinciding with the attacks of pain and screaming. Rigidity is absent, but in spite of this these children are difficult to examine and the tumour may be elusive, being soft in between the attacks of pain or possibly having ascended above the costal margin. The greatest possible care must be taken in this examination, both the abdomen and the rectum being carefully investigated, while if there is the least doubt, a few breaths of chloroform should be administered, as this will render the examination far easier, and sometimes the tumour can be felt only by this means. Care must be taken not to mistake the edge of the liver for a tumour of this kind. The rectum always should be examined, and if a swelling is felt the slit-like apex should be sought for. Often on withdrawing the finger from the rectum the characteristic prune juice will be seen upon it. Another feature of value may be a characteristic emptiness and absence of resistance in the right iliac fossa, the cæcum having departed thence; this is known as the "signe de Dance."

The average intussusception probably remains reducible up to eighteen hours or so. After this it becomes irreducible and soon gangrenous.

The only conditions which are liable to give rise to difficulty in diagnosis are:—

(*a*) *Acute Enteritis.* Here the vomiting and diarrhœa are more pronounced and the motions contain fæcal or green matter, while no tumour is present; and

(*b*) *Henoch's Purpura.* Here vomiting, intestinal colic, blood in the stools, and a palpable tumour due to subperitoneal hæmorrhage round a coil of bowel may occur. The true condition, however, should be revealed by the purpuric eruption and joint pains.

The intussusceptions which occur in small babies are nearly always of the enterocolic type (*i.e.*, either ileocæcal or ileocolic). Moreover, there is very rarely found to be any organic cause in the form of a growth or polyp. In larger children from three years old and upwards intussusceptions are nearly always of the pure enteric variety and are commonly due to a polyp, sarcoma, Meckel's diverticulum, etc. They are very acute and tight; gangrene is common and the symptoms are very similar except that, being higher up the bowel, the tumour lies more centrally, and blood and mucus are not usually present in the stools. The treatment (see below) is the same, and the older the child the better the prognosis.

Treatment. The old-fashioned methods of treatment by dilating the colon with injections of air or water, or instilling a mixture of shot and oil into the rectum or their modern prototype of attempting reduction on an X-ray table by means of a barium enema, are not worth trying and should be entirely ignored, as the only satisfactory treatment consists in instant laparotomy.

If a general anæsthetic is given these small babies are liable to chest complications, while they are difficult to relax; some surgeons think, therefore, that the operation is better done under spinal anæsthesia, an average dose for a child of six to eight months being 0·5 c.c. of a 2½ per cent. solution of stovaine and glucose (Vol. I., Ch. XXIV.). The abdomen is opened low down on the right side, the intussusception discovered, and the first part reduced by introducing two fingers and gently pushing it back; the last part is then gently brought up to the wound. Though the first part is reduced easily, difficulty will be encountered towards the end, and it must be remembered that the bowel is very friable and easily torn, and on no account must the entering loop be pulled out. The intussusception should be squeezed just beyond the apex and the intussusceptum in this way milked back. The reduction of the last part may be very difficult owing to œdema; this will be assisted by gently squeezing the œdematous portion with gauze wrung out of warm saline for a few minutes. Before reduction is complete the appendix will appear, and often a curious dimple in the cæcum. There is probably no operation in surgery in which practice more easily produces perfection. The more difficult cases the surgeon encounters the more easy their reduction becomes. A pair of blunt-nosed forceps can be used sometimes to stretch the constriction at the commencement of the intussusception and thus enable reduction to be achieved. A certain number of cases will be encountered, however, which are irreducible, though to the expert surgeon these are very few in number. We are then faced with the following possibilities:—

(*a*) *Jessett's Operation,* in which the entering and ensheathing layers are united by sutures at the neck, the intussuscipiens incised, the intussusceptum removed from within it, and the incision in the intussuscipiens closed. This imitates the process of natural cure, but is a difficult operation with poor results. It is only possible provided the sheath is not gangrenous.

(*b*) The performance of a *short-circuit* above and below the intussusception; this relieves the obstruction, but still leaves the possibility of gangrene occurring with peritonitis.

(*c*) A formal *resection of the intussusception* may be done and the ends joined up. This is an operation of the greatest gravity in a collapsed small baby, and we only know of one case, in a child under a year old, which has recovered. In older children, however, the outlook is far better.

(*d*) The formation of an *artificial anus.* The infants rarely recover if this is necessary.

(*e*) The intussusception may be brought out of the wound and sutured there while a Paul's tube is introduced above it; at a later date, if the child survives, it may be resected.

(*f*) As a small number of cases undoubtedly undergo spontaneous cure by the intussusceptum sloughing and passing, the chances of this occurring are rather greater than the chance of a baby under a year old surviving any of the above procedures. If the intussusception is irreducible in a tiny child it is probably therefore better to leave it and to close the abdomen.

In an adult or older child resection and end-to-end union offers a good chance of a cure.

Many surgeons make a practice of removing the appendix at the same time; it, however, should be remembered that these tiny babies' abdomens must be opened for the shortest possible period. If the intussusception is reduced easily and the child seems fit, there is no objection to appendicectomy, but otherwise the few extra moments required may suffice just to turn the scale against the baby. If the cæcum seems abnormally mobile, it may be advisable to introduce a few sutures in an effort to fix it into the right iliac fossa in order to prevent recurrence, for recurrence of an intussusception is not uncommon; when it does occur it is not infrequently within a few days of the operation, and it may happen several times in the next six months.

After a large intussusception has been reduced, a foot or more of bowel will be purple, bruised and congested, and this sometimes proves fatal. Some cases develop hyperpyrexia after operation and die, probably owing to toxic absorption from this damaged bowel. After these operations every effort must be made to treat the collapse.

It should be remembered that small babies exhibit a distinct tendency to burst their wounds open after a laparotomy; it is advisable, therefore, to suture these abdomens in layers and to introduce some stitches through-and-through the skin and rectus sheath; also to leave the sutures in rather longer than usual.

Chronic Intussusception. Chronic intussusception is rare but more common in the adult than in the child. It is seen in people over sixty, is usually of the pure colic type, and may be due to a carcinoma of the colon, which has been its starting point. The symptoms are those of subacute obstruction without strangulation, and consist of attacks of colicky pains at intervals during several weeks or months. Constipation is often not marked, and mucus and blood are frequently present in the stools. Tenesmus and gradual loss of weight occur, but the patient may remain fairly fit for some months.

On examining the abdomen during an attack distension and visible coils of bowel will be seen. There is no tenderness or rigidity and the characteristic sausage-shaped swelling will often be discovered. If not treated properly, it is likely that in the course of some months complete obstruction or peritonitis from ulceration or perforation will occur. Occurring as it does in people over forty, it naturally closely resembles a carcinoma of the colon. An opaque meal will assist in the diagnosis.

Treatment. These intussusceptions, though not gangrenous, are nearly always irreducible. The only treatment, therefore, consists in laparotomy, and often the diagnosis will not be made until this is performed. An attempt should then be made to reduce the condition, but this is not likely to succeed, and then resection, with union of the bowel ends, will be necessary. The results of this procedure are generally very good.

Mesenteric Embolism and Thrombosis. Though almost always present when strangulation has occurred, this condition sometimes arises spontaneously and gives rise to acute obstruction as a result of complete paralysis of the coils of bowel affected. The disease is usually due to an embolus in one of the mesenteric arteries, the embolus generally coming from a cardiac vegetation; occasionally cirrhosis of the liver causes a thrombosis. The portion of the mesentery affected becomes congested, thickened and purple, while the coils of bowel attached to that mesentery are also congested and purple, and frequently become gangrenous; the peritoneum and lumen of the bowel become full of blood-stained effusion.

The condition is most common in middle-aged men, and should not be diagnosed unless some cause for the embolism or thrombosis is found, such as cardiac disease, severe anæmia or cirrhosis of the liver. There is sudden onset of intense abdominal pain, with shock, vomiting, abdominal distension and all the signs of very acute obstruction (see p. 678). Rigidity is often marked in this form of obstruction. In addition to this, the patient may pass one or more stools containing dark blood, and a soft, ill-defined tumour may be felt which is formed by the engorged and congested coils. Gangrene and peritonitis set in very soon and the condition is very grave.

In many of the milder cases complete gangrene of the bowel walls is not present and in such cases expectant treatment should be adopted, though this is always risky as it is difficult to judge of the condition of the bowel without laparotomy; intravenous drip saline and morphia should be given for several days. In many cases sloughs of the mucosa are passed per rectum and stricture of the bowel may occur subsequently.

Where gangrene is present the only treatment consists in instant laparotomy, with removal of the affected coils and mesentery. As the condition usually occurs in the small intestine, an end-to-end union can generally be performed. The peritoneum will be found full of blood-stained fluid. It is not uncommon, even after this operation, for the condition to recur, with further thrombosis, in a few days. Should this occur no further operation had better be undertaken (see also p. 727).

Enterospasm. This is an uncommon functional condition of unknown pathology, seen in neurotic individuals, where one or more coils of bowel go into cramp-like contraction, lasting for some minutes or hours; it is usually seen in the colon, and especially on the left side. In neurotic women especially a spasm of either the cæcum (or more commonly the left side of the colon) is not rare. It may cause either severe colic or dull aching. There is no hypertrophy of the bowel wall, while an X-ray film with barium will show marked delay and the areas of spasm may resemble a ring carcinoma. An associated colitis is often present, while the contracted colon may be felt in the left iliac fossa. Severe abdominal pain, with constipation and vomiting, occur, and though in most instances the condition suddenly passes off within a few hours, the surgeon is not infrequently led into the performance of a laparotomy by the apparent gravity of the symptoms. If this is done nothing will be found but one or more tightly contracted coils. The only available treatment consists in anti-spasmodic drugs and medical treatment for the patient's general condition.

In rather more chronic and recurrent forms biliary or other forms of colic will be mimicked.

In visceroptosis and cases with calcified mesenteric glands it is probably spasm of the bowel which is largely responsible for the pain (see Vol. I., Ch. XII.).

Obstruction due to Growths of the Colon. This is a very common form of obstruction and is described on pp. 669, 670.

Strangulated External Hernia. See Chapter XIV., p. 569.

PARALYTIC ILEUS

This is a condition in which, as a result of complete paralysis of the whole or parts of the bowel, symptoms closely resembling those of acute obstruction are produced without there being any organic block. It may be due to the following causes:—

(*a*) After laparotomy, when the bowel has been handled severely or been withdrawn from the abdomen and exposed to the air without protection by warm cloths; it especially follows pelvic operations and operations in stout people.

(*b*) As the result of infection of the peritoneum, either general peritonitis, localised peritonitis, or localised abscess (see pp. 533–544).

(*c*) As the result of mesenteric embolism or thrombosis and torsion or lesions of other abdominal viscera.

(*d*) After fractured ribs (see p. 429) or injuries or diseases of the spinal cord (see Chapter III.). Tabes, lead poisoning, uræmia and hysteria also may cause a similar condition.

(*e*) Very rarely, after a normal confinement.

In those cases which are due to infection of the peritoneum the condition not unnaturally usually arises after an operation. In these cases it is possible that the main paralysis and obstruction occur, as described by Sampson Handley, at two points (*ileus duplex*), where the bowel is bathed in the purulent fluid which has run down into the pelvis. These two points are probably one or more coils of ileum hanging down into the pelvis, and the pelvic colon itself. In some instances there seems to be a personal idiosyncrasy towards this condition. At times the bowel is so distended that it becomes thin and translucent. Ulceration and erosions may occur, and these are partly the cause of the black vomit which sets in at the end (see also Vol. I., Ch. XII.).

Clinical Features. The clinical features of this condition are very marked. Whatever the cause of it is, the patient's abdomen gradually becomes more and more distended in the course of a day or two, the distension finally becoming enormous. There is little or no pain, but great discomfort from the distension ; there is no visible peristalsis and absolute silence on auscultation. The temperature is usually subnormal, while after a time the pulse begins to rise and vomiting sets in, the ejecta being at first green, and finally black and fæculent, and rolling out of the mouth in the effortless way described on p. 538. Sometimes no vomits occur until one or two profuse ones just before death. Pain, rigidity, tenderness, and visible peristalsis are all absent.

Treatment. Any patient in whom this condition is setting in, especially after a laparotomy, is in an exceedingly grave state. Subcutaneous saline or continuous intravenous drip saline and glucose should be given in all cases, and is best commenced early as its administration does much to allay thirst and delay the onset of vomiting and collapse. If vomiting is present a small tube may be passed and left in the stomach, or better in the duodenum. If a suction apparatus is applied to this the stomach will be kept empty and the vomiting relieved. The patient must be supplied with plenty of fluid intravenously while this suction is going on and morphia given freely to secure rest. Every effort must be made to establish peristalsis without unduly exhausting the patient or irritating the bowel. We recommend the following procedures in order :—

(*a*) The administration of pituitary hypodermically.

(*b*) The administration of eserine hypodermically, in four-hourly doses of $\frac{1}{50}$ gr. The first dose of pituitary is more likely to act than successive ones, while repeated doses of eserine give the best results. If this fails a large dose of prostigmine (up to 5 c.c.) will sometimes succeed. Doryl (1 c.c.) is useful at times.

(*c*) The passage of a flatus tube.

(*d*) The administration of enemata of turpentine or ox bile or even asafœtida. Better still are enemata of human bile or the bilious vomit of the patient (see p. 538). Another enema which is at times successful is a " milk and molasses enema." Glycerine suppositories may help.

(*e*) The application of radiant heat to the exposed abdomen for periods of half an hour. This is sometimes astonishingly effective, and may be assisted by the application of hot fomentations in the intervals.

(*f*) If no vomiting is present the administration of calomel, followed later by salts.

(*g*) As accessory methods washing out the stomach and abdominal massage will be useful occasionally.

(*h*) In a few cases the administration of a spinal anæsthetic permits the flatus to escape by producing complete relaxation of the sphincters.

(*i*) The administration of B. welchii serum. 20 c.c. should be given daily to an adult intramuscularly until the bowels are acting properly.

(*j*) Acetylcholin may be given in doses of 0·1 gram hourly for five or six doses.

If in spite of the above methods the condition continues, a grave decision will have to be made as to whether the abdomen should be reopened or not, with a view to performing a jejunostomy to drain the bowel. It must be remembered that in a few of these post-operative cases an organic obstruction may be present, but in this case it is probable that pain and peristaltic sounds on auscultation will render the diagnosis fairly definite. In the purely paralytic cases many surgeons advocate that a jejunostomy should be performed, but we must admit that we have very seldom indeed seen any good come of this, as the bowel is so paralysed in most cases that only the coil in which the tube actually lies is likely to empty itself; we are therefore opposed to this procedure, and are still more against the performance of any sort of anastomosis or short-circuit in an effort to relieve the condition. There are very few conditions indeed in abdominal surgery which to a wise surgeon justify a second opening of the abdomen shortly after a laparotomy.

OPERATIONS UPON THE INTESTINES

Methods of Intestinal Suture. Three main types of intestinal suture are employed:—

(*a*) A *through-and-through suture,* which may be continuous or interrupted and passes through all coats of the bowel.

(*b*) *The Lembert inverting suture.* This is usually employed as a reinforcing layer to invert a previous through-and-through layer of stitches. These stitches pass only through the peritoneum and muscular coats into the submucous layer. They do not penetrate the mucous membrane.

(*c*) *The Connell suture,* sometimes known as the "loop-on-the-mucosa stitch." This passes through all layers and automatically inverts the edges (Fig. 190).

These sutures may be performed with either continuous or interrupted stitches, preferably the former. Either silk or catgut may be used, the former being the more reliable.

(1) **Enterotomy.** This operation consists in opening the bowel for inspection or the removal of a foreign body or growth and then closing it again. A clamp is applied, the peritoneum carefully packed off, a longitudinal incision is made in the antimesenteric border, the necessary procedure performed, and the opening is then closed in a transverse direction, to avoid narrowing the bowel lumen, by a through-and-through continuous stitch, reinforced and inverted by a continuous Lembert suture.

(2) **Enterostomy.** This consists in making an opening in the bowel for drainage purposes. It is employed in obstruction, paralytic distension, or as a means of introducing food into the bowel, where for some reason the stomach is out of action. It is known as *jejunostomy, ileostomy, cœcostomy,* or *colostomy,* according to which portion of intestine is employed.

If the opening is to be in the small intestine the abdomen is opened just to the right of the midline, a suitable coil is brought out and clamped and the peritoneum protected. The coil is opened, a tube introduced and fastened in with a catgut stitch; the opening round the tube is then inverted and made watertight by a purse-string suture. Either a rubber tube or a small Paul's tube may be employed. The coil of bowel is then placed within the abdomen and fixed to the abdominal wall close to the incision, the tube being brought out through the omentum; the abdomen is closed and the tube connected with a long drain which passes out of the bed. It must be realised that this is only a temporary measure, for starvation, with rapid inanition, may follow the escape of small intestinal contents, while the skin of the abdominal wall will soon become digested and sore. As soon as possible, therefore, within a week or two at most, some further procedure must be undertaken to relieve the obstruction and to allow the intestinal contents to pass on.

When a *jejunostomy* is performed for purposes of artificial feeding a coil of jejunum as high as possible is selected. A valvular opening has now to be made in order to permit food to enter the bowel without the contents escaping, and this is done on exactly the same lines as in Witzel's gastrostomy (see p. 641). The coil of bowel is then replaced and sutured to the anterior abdominal wall.

Another method of performing this operation, known as *Maydl's jejunostomy*, consists in cutting the jejunum across and planting the upper cut end into the side of the lower portion 3 or 4 inches below its open end and bringing the open lower end up to the surface of the skin through the abdominal incision and fixing it there.

Another frequently performed variety of enterostomy is that known as a **Colostomy.** Here an opening is made into some part of the colon, either temporarily or permanently, to allow the fæces to come out above an obstruction. It is also employed in certain diseases of the colon to divert the fæcal current. The type of operation will depend upon the condition for which it is performed. Thus, when performed to divert the fæcal stream, or as a permanent measure above a rectal growth, *a spur* must be made, while if it is simply required as a temporary measure to relieve an obstruction, no spur is required, so that merely a lateral opening is made in the colon.

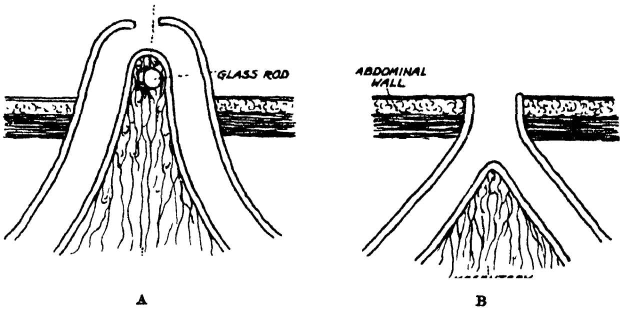


FIG. 249. (A) Colostomy with a spur. (B) Colostomy without a spur.

(*a*) If a spur is required the portion of bowel in which it is determined to make the opening is brought out of the wound, and when the abdominal wound is closed a coil as small as possible is left outside the wound and fixed there by a glass rod passing through its mesentery; the rod should lie without tension flat against the skin on either side of the wound. The bowel is attached to the peritoneum by a few silk stitches and the abdominal wound snugly closed round it. If possible, and if the obstruction is not urgent, the bowel is not opened there and then, but a small portion, about the size of a sixpence, is cut out of it twenty-four or forty-eight hours later, as by this time the peritoneum will have become sealed off. This will not require a second anæsthetic.

Should it be necessary to open the colostomy at once, a Paul's tube should be firmly tied in with silk or a piece of tape so as to prevent soiling of the recent wound. This Paul's tube probably will drop out in three or four days, when the ligatures keeping it in work loose. The glass rod keeping the colostomy out must not be removed for at least ten days, or there is a risk of the bowel falling back.

Some surgeons prefer to perform a colostomy by cutting the bowel right across and fixing the two ends in the wound separately. This is especially practised as a preliminary to the abdominoperineal, or other methods of removal of the rectum.

(*b*) When no spur is required the coil of bowel concerned is brought up to the abdominal wall, fixed to the peritoneum with a few silk stitches and opened, a Paul's tube or other tube being inserted. There is no necessity for the coil to be brought outside the abdomen.

Paul's tubes occasionally fail to act owing to the muscles of the abdominal wall gripping the bowel above the tube. This can be prevented by using a Paul's tube with a prolongation made by jamming a big piece of rubber tubing tightly into it, which will pass up inside the bowel for 2 or 3 inches.

Whenever a colostomy is performed, and in whatever part of the colon, the bowel should be drawn up into the wound until its upper end is reasonably taut. By this means alone can a subsequent prolapse of the bowel be prevented.

Any part of the colon may be selected for the operation, but the pelvic colon and transverse colon are by far the most commonly employed (iliac and transverse colostomy). The portion of colon selected naturally will depend very largely upon the nature and site of the lesion for which the colostomy is performed.

(1) **Transverse Colostomy.** This is, of course, necessary for obstructions of the splenic flexure or descending colon, while many surgeons prefer to perform it for other lesions lower down. For choice this operation should be performed through an incision made by splitting the upper part of the left rectus and incising the peritoneum transversely ; the split muscle will then grasp the colon and form more or less of a sphincter. This operation has the following advantages over that described below : it is easier, the bowel concerned has a longer mesentery and is more mobile, a better sphincteric action is obtained by the rectus, and it is farther away from any subsequent operation which may have to be performed in the lower part of the abdomen, while a belt fits more easily in this situation. On the other hand, the fæces are a trifle more liquid and prolapse rather more frequent.

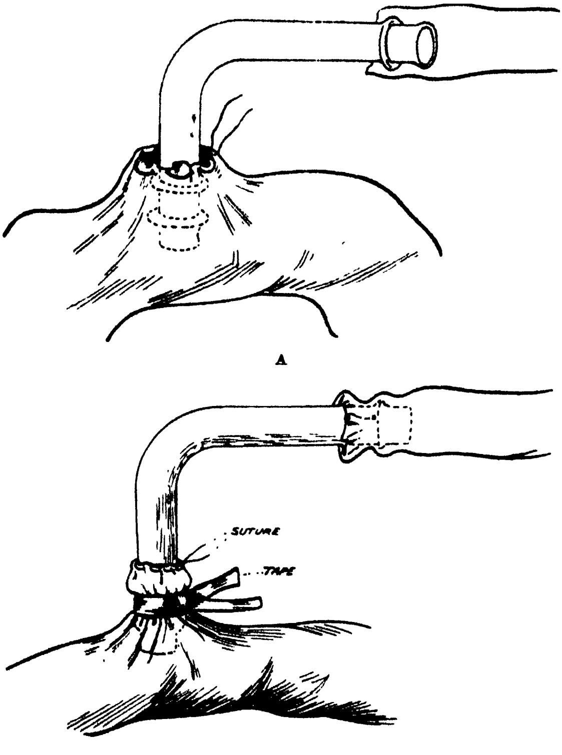


FIG. 250. Insertion of a Paul's tube. (A) Tying the tube in with a ligature above both flanges. (B) Strengthening this with a tape tied between the two flanges.

(2) **Iliac Colostomy.** In this the sigmoid flexure is opened through an incision which may be either a muscle-splitting, gridiron incision, exactly like McBurney's appendix incision (see p. 719), only in the left iliac fossa, or by an incision which splits the lower half of the left rectus. This operation has the advantages that it preserves as much of the colon as possible. It has disadvantages however ; a belt is less easy to fit in this situation, while if the pelvic colon is greatly distended, as is usually the case when the operation is performed for an obstruction low down, the

distension of the bowel takes place very largely at the expense of the length of the mesentery, so that we may encounter a distended pelvic colon which cannot be brought up to the skin surface at all. Moreover, the situation of the opening may be very much in the way of any subsequent operation that may be necessary upon the lower abdomen.

The old-fashioned *lumbar colostomy*, which was much performed by our ancestors on account of their fear of opening the peritoneum, is now quite out of date.

As soon as a colostomy wound is soundly healed, *i.e.*, in about a fortnight, if it is intended to be permanent the patient must be provided with a proper colostomy belt, consisting of a rubber belt with a hollow round cap made of metal or vulcanite and with a small rubber bag attached to it to collect whatever comes out. He should also be instructed how to wash out the colostomy thoroughly every morning. By this means he will get about in comfort during the day, and in most cases the patient soon learns to control and wash out a colostomy in such a way that it only acts once a day and leaves him comfortable and free the rest of the time.

A colostomy is very rarely performed in the ascending colon, but in the cæcum it is common, and here it is known as a **cæcostomy.** This is nearly always only a temporary procedure, necessary for growths of the ascending colon, for colitis and dysentery, or as a safety valve after a colonic resection with an anastomosis. The opening should be small, as the fæcal contents here are liquid and irritating, and care must be taken not to let the skin become digested (see p. 675).

Closure of a Colostomy. This is an operation not infrequently required, though a properly performed temporary colostomy will often close spontaneously when the cause of the obstruction is removed.

The method of procedure will depend upon whether a spur is present or not.

If there is no spur it will be sufficient to dissect down upon the colostomy opening, identifying and separating the various layers of the abdominal wall until the wall of the bowel is discovered. This is dissected free for a short distance without opening the general peritoneal cavity ; the opening in the bowel is then closed with a continuous suture and the layers of the abdominal wall sutured over it. This operation is sometimes known as *Greig-Smith's operation* (p. 676).

Should there be a spur the same procedure may be attempted, but is not so likely to succeed. In some cases the bowel may be forced back and the spur partially obliterated as a preliminary proceeding by inserting the two ends of a stiff piece of rubber tubing into the two loops of the colostomy and tying it there for some days. The tendency of the tube to straighten itself will then force the spur in. In most cases, however, when a spur is present it will be necessary to resect a small portion of the bowel containing the opening and spur and unite the ends by end-to-end anastomosis (Enterectomy, see below). A circular incision is made around the colostomy, the abdomen is opened, the two loops of bowel are carefully detached from the abdominal wall and the resection is performed. As a preliminary to this proceeding the colostomy opening must be sewn up carefully to avoid fæcal soiling.

(3) **Intestinal Resection, Enterectomy.** Removal of a greater or lesser portion of the bowel is often required for such conditions as gangrene as a result of strangulation, the removal of growths, for serious injuries of the bowel, to remove chronically distended and overgrown portions of the bowel, and the closure of a colostomy or fæcal fistula, etc. The situation and amount of the bowel to be removed naturally will depend upon the nature of the lesion for which it is done, while the result and mortality of the procedure will depend also upon the same conditions as well as upon the skill of the surgeon. If there is no urgency careful preparation for some days beforehand should be made with the object of getting the bowel as empty as possible and rendering it as aseptic as possible by means of intestinal antiseptics. It should be remembered that under no circumstances should a coil of bowel be removed and an anastomosis performed when acute obstruction is present with the exception of cases of gangrene of the small bowel from strangulation ; here it is justifiable. In some cases, such as malignant disease or where the mesentery is thrombosed or gangrenous, it is necessary with the coil of bowel to be removed also to excise a deep V of the mesentery. In many cases this actually shortens the operation, as fewer mesenteric vessels will have to be cut and tied. In other cases, however, it is not necessary to remove the mesentery as well. As a general rule it is better to remove a V of the mesentery in extensive resections and to leave the mesentery in smaller ones.

The incision will depend, of course, upon the nature of the lesion, and the surgeon will make up his mind carefully as to how much of the bowel it is necessary to remove. The general peritoneal cavity is then carefully packed off and clamps are put upon the bowel at the proposed sites of section, two clamps being placed at each end of the coil to be removed. In the case of the small intestine these clamps should be placed obliquely, so that when the bowel is cut across between each pair of clamps rather more of the anti-mesenteric border will be removed than of the mesenteric border. This is necessary in order to ensure that there is a good blood supply to the extreme edge of the incision in the anti-mesenteric neighbourhood; moreover, the oblique cut provides a larger lumen to the bowel for suturing purposes. It is wise to cut and tie all the necessary part of the mesentery and its vessels before the bowel is cut across in order to set the bowel free and preserve the aseptic nature of the operation as long as possible. The bowel may be cut with the knife or the cautery, and having removed all the required portion of bowel it will be necessary to join the ends together. There are three methods of doing this, side-to-side (lateral), end-to-end and end-to-side anastomosis. All methods of bowel union by means of metal or bone bobbins and buttons have been entirely given up in favour of plain and straightforward suturing.

Recently, by means of special guillotine needles or long, fine clamps, methods of intestinal union have been devised by means of which the bowel is not actually opened and cut right across until all the suturing is completed. There is thus no chance of peritoneal soiling. Special works must be consulted for these methods.

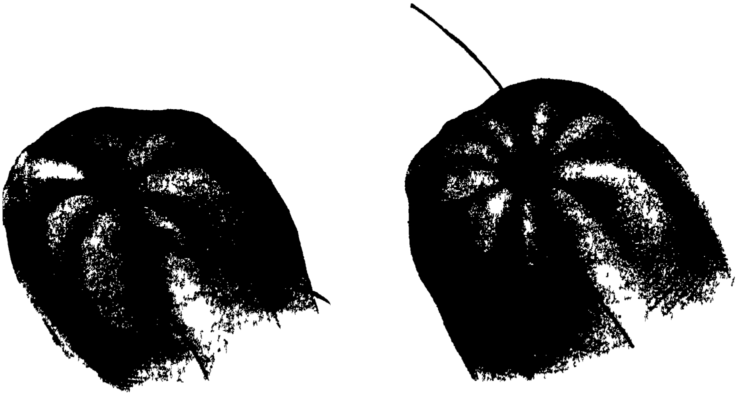


FIG. 251. (*a*) Invagination of the end of the bowel with a purse-string suture after it has been crushed and tied. (*b*) Invagination of the bowel by means of a Z suture.

(A) **Side-to-Side Anastomosis.** In performing a lateral anastomosis the two ends of the bowel must be closed first. There are many ingenious methods of doing this, most of which come into action while the bowel is being sectioned. Thus the bowel may be crushed and tied, cut with a cautery or knife, and the tied end invaginated with a purse-string suture; or a simpler method still is to employ a Parker-Kerr clamp, by means of which the cut end may be closed and invaginated automatically with one suture, a second reinforcing one being afterwards added. The closed ends of the bowel are then overlapped and brought into apposition, facing in opposite directions, this constituting an isoperistaltic anastomosis, by far the best form. The only case in which an antiperistaltic anastomosis is perhaps more satisfactory is after a resection of the splenic flexure. The two ends of bowel being brought into apposition, an anastomosis is performed exactly as in gastro-enterostomy by means of an outer layer of continuous Lembert inverting sutures and an inner layer of continuous through-and-through sutures; this may be of either catgut or silk. The details of the suturing are explained on pp. 642–647. The openings in the bowel should be as near their closed ends as possible. The two cut edges of the mesentery are then lightly sutured to the corresponding portions of the mesentery with which they are in apposition to prevent bowel becoming strangulated through this aperture.

A lateral anastomosis of this kind is often used to short-circuit the bowel above and below a growth without actually resecting it. Inasmuch as any form of intestinal anastomosis must be performed through a peritoneal covered portion of the bowel wall, lateral anastomosis can be performed in any part of the bowel whatsoever, and is therefore probably the most satisfactory. It must be remembered, however, that the overlap demands that the bowel ends shall be very easily brought together.

(B) **End-to-End Anastomosis.** This form of union is quicker to do than the foregoing and uses up less bowel. It can be performed, however, only in those parts of the bowel which are completely covered all round with peritoneum, and only if the lumina of the two ends are approximately equal. Thus it is perfectly satisfactory in the small intestine and the pelvic and transverse colons, but should not be used elsewhere. Clamps being put across the bowel, and the two ends thus being held in apposition, it is quite possible to perform the operation on exactly the same lines as a gastroenterostomy, introducing first the posterior layer of continuous inverting Lembert sutures, and then the posterior layer of the through-and-through sutures, this through-and-through suture being continued round the anterior edge of the bowel, while finally the anterior layer of the Lembert inverting suture is completed. A more satisfactory method as a rule, however, is first of all to introduce a stitch through the bowel wall, to obliterate the dangerous triangular space formed by the separation of the two layers of the mesentery where it meets the bowel. Both ends of the bowel are treated in the same way and by the same stitch, so that when it is drawn tight the mesenteric borders are brought into apposition. This stitch is left long, and a traction suture is passed through the two anti-mesenteric borders. These two stitches are held by the assistant, and a continuous through-and-through stitch of silk or catgut joining the two ends together is then passed completely round the circumference of the bowel. This should be knotted upon itself two or three times to prevent it drawing too tight. The continuous Lembert inverting suture is then inserted all round the bowel and tied upon itself. The spot where the greatest care is required is the dangerous triangular area at the root of the mesentery, for here leakage is most likely.

Where the time taken over the operation has to be reduced to an absolute minimum one continuous layer of Connell's sutures will be found quite safe (Fig. 190).

(C) **End-to-Side Anastomosis.** This is a more difficult form of union which demands that one end of the bowel at least shall have a complete peritoneal covering. It is most frequently employed after removal of the cæcum and ascending colon, or removal of the splenic flexure, while it is also of use where the two ends of the bowel to be joined together are of very unequal diameter. One open bowel end is closed; the other open end is brought into apposition with the side of the first portion of bowel as near its closed end as possible, and held there with clamps. The way the suturing is performed will be understood when it is realised that the method is really a combination of end-to-end union and lateral anastomosis.

(4) **Colectomy.** Resection of various portions of the colon is frequently performed for carcinoma. It is shortly described on p. 674. It will be realised that the fixed parts of the colon will need mobilising before any resection can be performed as there described. End-to-end anastomosis is hardly ever suitable, and lateral union is usually the best. After any such anastomosis in the colon it is always wiser to make a temporary cæcostomy, to act as a safety valve.

CHAPTER XVII

DISEASES OF THE APPENDIX AND THE DIAGNOSIS OF THE ACUTE ABDOMEN

Surgical Anatomy. The appendix vermiformis is a vestigial or degenerative relic, and as such is particularly liable to various attacks of inflammation. It probably has no function whatever, but it may be associated in some way with fat metabolism, while some authorities hold that it stimulates peristalsis in the large bowel, possibly by means of a secretion. In herbivorous animals, such as the rabbit and horse, it is evidently a very much more important organ, its size being out of all proportion compared with that of the human being, whereas in the purely carnivorous animals, such as the cat family (lions, tigers, cats, etc.), it is even smaller and more atrophied than in man. It contains in its submucous coat a considerable amount of pure lymphoid tissue, resembling the tonsil in this respect, while it must be remembered that it constitutes a cul-de-sac or test tube, possessing no direct through-and-through current and forming a resting place highly suitable for the deposit of hard masses of fæcal material and for the growth and development of bacteria. It is usually a very movable organ with a free mesentery, in the edge of which its artery of supply runs, but the tip of the appendix certainly often receives a very poor supply, as frequently the mesentery does not extend right up to it, while this latter structure is easily twisted and interfered with. All these facts render the organ particularly liable to bacterial infection.

It communicates with the cæcum by a small opening, which is guarded by a valve-like structure known as the valve of Gerlach. If this opening or the lumen of the appendix becomes obstructed either by swelling and congestion, twisting or kinking, fibrous stricture or the presence of semisolid fæcal material, the liability to virulent inflammation is very greatly increased, and the appendix may then become distended with fluid varying from simple and more or less sterile mucus to the most virulently infective pus. In most instances the appendix is completely surrounded by peritoneum, and lies more or less free within the peritoneal cavity ; the latter structure, therefore, is particularly liable to become involved in its inflammation.

The length of the appendix varies from 1 to 10 inches, being usually about 3 or 4 inches, whilst the position in which it lies varies greatly, the most common positions encountered being :—

(*a*) In a direction running upwards and inwards behind the bottom few inches of the ileum and pointing towards the spleen (30 per cent.).

(*b*) Running straight downwards from the cæcum and hanging over the brim of the pelvis. In this situation it is brought intimately into contact with the iliac vessels and pelvic contents. It is then known as a *pelvic appendix* (20 per cent.).

(*c*) Pointing directly upwards and lying either behind the cæcum and ascending colon or to the outer side of these structures (50 per cent.). In the former of these two instances it is more or less shut off from the peritoneal cavity, and usually lies closely tied on to the back of the cæcum by a peritoneal fold, being really a retroperitoneal organ. In these two situations it is known as an *extracæcal* and *retrocæcal appendix* respectively.

The situation and length of the appendix exerts a considerable influence upon its liability to inflammation, the symptoms which that inflammation may produce, and the tendency and direction of spread of the inflammation.

The *lymphatics* of the appendix pass up into its mesentery, in which there are one or two small glands, to some larger glands in the neighbourhood of the ileocæcal junction, and from thence to the main glands on the course of the superior mesenteric vessels.

The appendix normally contains semiliquid fæces, a little mucus, and the bacteria which are present in that part of the intestine chiefly colon bacilli, anaerobic organisms, streptococci and staphylococci. As long as its lumen is patent and its mucosa is intact these organisms are not likely to produce any pathological effects.

In addition to this, solid bodies are not infrequently present; very rarely these are foreign bodies in the form of seed pips, toothbrush hairs, and pins. More commonly appendicular fæcal concretions are present. These, which are the result of appendicular stasis, are small oval bodies of about ¼ inch in diameter, sometimes hard, sometimes soft and easily crushed, and consisting of dried fæces and the calcified salts of fatty acids, and full of organisms. They tend gradually to increase in size, and are sometimes visible in an X-ray film, being often accompanied by the formation of intestinal sand. They are probably both the cause and the result of obstruction and inflammation of the appendix.

The most severe types of inflammation are usually found to be due to a mixture of streptococci and B. coli.

The surface marking of the opening of the appendix into the cæcum is usually given as a point 1 inch below the junction of the right lateral and intertubercular planes.

APPENDICITIS

This very common disease, which consists essentially of a bacterial inflammation of various parts of the appendix and surrounding structures, divides itself into three chief groups of acute appendicitis, chronic appendicitis and recurrent or relapsing appendicitis. These terms more or less explain themselves. Other forms of inflammation of the appendix, such as those due to tuberculosis, actinomycosis, typhoid, etc., will be considered later.

(A) ACUTE APPENDICITIS

Ætiology and Pathology. No age is exempt from this disease and no race. It is, however, far the most common between the ages of six and forty-five, in the male sex, and in the civilised races. It is exceedingly rare among savages and those who eat little meat, and very rare in animals; in Egypt, South-East Europe and India it is also uncommon. It varies in virulence enormously, and is undoubtedly more severe in males than in females; it usually attacks those who are in good health, while there is little doubt that previous attacks predispose to others. There are many theories which attempt to account for its enormously increased frequency in the last thirty years among the civilised races and especially among town dwellers. There is little doubt that eating of meat predisposes to it, and that constipation, the eating of unsatisfactory and hastily-consumed meals, the presence of dental and oral sepsis, and possibly the introduction of frozen meat, all play a part in its production. In some cases injury undoubtedly stimulates an attack, but this is rare; it is possible that a twist, blow or strain will kink the mesentery and interfere with the blood supply, or will cause a concretion to move and completely block the appendix. Moreover, when distended, a blow certainly may lead to rupture or perforation of the organ.

The older theories that the disease was frequently due to the presence of foreign bodies within the appendix, such as grape-pips, pins, seeds, toothbrush hairs, pieces of enamel from dishes, fragments of steel in flour from mill grinders, etc., have little to support them, as such bodies are very rarely found.

Many cases are accompanied by a considerable degree of general colitis, while there is probably some connection between the disease and both influenza and rheumatism, and it is not infrequently present in conjunction with tonsillitis, or in children who have had their tonsils removed previously. It must be remembered also that the frequency of the disease is rendered more apparent by the improvement in modern abdominal diagnosis.

(1) *Changes in the Appendix.* The first pathological change in the organ

is an acute inflammation of its submucosa which rapidly spreads to the mucous membrane. This acute inflammation may remain confined to the mucous membrane, but frequently spreads from this to the muscular wall as well, while as a corollary the peritoneal coat will soon become involved also. Thread-worms are not infrequently found in the appendix when this degree of inflammation is present, but not in the more severe degrees.

At this stage the organ looks red and swollen, and is stiff and hard, while its peritoneal coat may be red and have flakes of lymph upon it, the whole condition being one of *acute catarrhal inflammation.*

At this point the inflammation may spread no further, and may gradually subside, resolution occurring and being accompanied by a considerable fibrosis which replaces the muscle in the wall of the viscus ; and in this case the whole organ may become sclerosed and fibrosed, even becoming permanently obliterated and solid, or else one or more fibrous strictures may form. This, if marked enough, will lead to obstruction of the appendix, in which case fæcal concretions are liable to form above the stricture or the distal portion of the organ may become distended gradually with mucus (mucocele) or pus (empyema). When this obstruction of the lumen is present, the patient is undoubtedly in danger of other and more severe attacks. Occasionally, as the result of inflammation, little pouches or bulges form in the muscular wall of the organ, and should other attacks of inflammation occur, these will predispose greatly towards perforation.

FIG. 252. Gangrenous appendix with three nails in it.

On the other hand, the inflammation may not stop at this point, but may progress further, and rapid spread and increase of the infection in the wall of the appendix is undoubtedly predisposed to by ulceration or erosion of the mucous membrane, the presence of fæcal concretions and any obstruction of the lumen of the tube. This, as already stated, may be due to fibrous strictures, twisting or kinking, swelling of the mucous membrane, the presence of fæcoliths and foreign bodies, or even occasionally of an early carcinoma of the appendix (see p. 719). Such spread of infection in the wall of the organ is accompanied by great swelling, œdema and redness of the peritoneal covering.

At any point *ulceration of the mucous membrane* may occur, and this is predisposed to by the presence of fæcal concretions pressing upon the wall, or of obstruction of the appendix leading to tension within its lumen. This ulceration may spread deeper into the muscular wall, and even right through the peritoneum, giving rise to a *perforation,* such a perforation being most commonly seen either near the tip or the base of the organ. When this occurs, either general peritonitis, local peritonitis or local abscess formation will set in, as the result of highly infective appendicular contents escaping into the surrounding peritoneum (see pp. 711, 712).

In other cases *sloughing or gangrene* of either the whole or a part of the appendix will occur. This may be the result of either thrombosis of the vessels in the appendicular mesentery, the pressure of fæcal concretions within the appendix lumen, or gross distension of the organ by inflammatory products, when its lumen is obstructed. Gangrene of this kind may be patchy to start with, or may involve the whole organ, which will then become green, yellow or black with a foul odour ; it sometimes becomes completely detached from the cæcum. The result of gangrene is also to lead to perforation, and concretions, when present, may escape through the perforation into the peritoneal cavity.

In all cases, *suppuration within the appendix lumen* is liable to occur, the organ then containing foul-smelling pus of a high degree of infectivity and which on rupture, perforation or gangrene of the organ will escape into the peritoneum.

The most acute and severe forms of the disease are those in which the lumen of the appendix is obstructed, either by strictures, kinking, fæcal concretions, adhesions or swelling of the mucous membrane. If the obstruction is absolute and the inflammation acute, an *empyema of the appendix* may form, while if fæcal matter is absent and the inflammation chronic, a *mucocele of the appendix* will be the result.

In severe cases changes also may occur in the cæcum (typhlitis) rather similar to those in the appendix. The cæcal wall close to the appendix is often red, congested and œdematous, though suppuration in or perforation of its muscular wall is not often seen. Actual gangrene sometimes spreads from the appendix on to the wall of the cæcum, an inch or two of which will then slough.

(2) *Changes in the Surrounding Tissues.* It is only in very chronic cases that the appendix alone is involved. When acute inflammation is present the peritoneal covering of the appendix is always inflamed to some extent, and in mild cases this is protective, in that the peritoneum of the appendix becomes roughened, covered with a coating of lymph, thickened and adherent to surrounding structures, especially the cæcum. This tends to prevent the spread of inflammation, while in cases where the inflammation settles down, it may result, after the patient is cured, in adhesions between the appendix and the surrounding ileum or any other viscus. It is not uncommon to find the greater omentum wrapping itself more or less completely round an inflamed appendix, and thus localising and shutting off the infection and forming an extra covering should perforation occur; in such cases the omentum undoubtedly may save the life of the patient.

In the more severe cases the peritonitis spreads rapidly, and does not remain confined to the appendicular region. This is due to failure in the production of sufficient adhesions owing either to the virulence or gross amount of the infecting organisms or to poor resistance on the part of the patient. When this occurs, four things may happen :—

(*a*) After spreading for a short time the infection may still become localised and finally settle down, causing no worse effects than the formation of adhesions.

(*b*) A *localised intraperitoneal abscess* may form (**appendix abscess**). Such an abscess does not appear usually for three or four days, and is the result of adhesions around a localised suppuration, the wall of the abscess being formed by omentum, bowel and the abdominal wall, all bound together by adhesions. Such an abscess usually contains thick, foul-smelling pus, together, perhaps, with concretions which have escaped from the appendix or sloughing portions of the organ. Gas will be present sometimes either as the result of anaerobic organisms or from the bowel itself (see p. 532).

The situation of the abscess depends upon the position of the appendix around which it lies. It is usually in the right iliac fossa, where it may be below, behind, to the inner or outer side of the cæcum, and as it increases in size it will bulge forward the abdominal wall above Poupart's ligament. Frequently it lies in the pelvis, when sometimes it may be felt on the left side while an abscess occasionally may be met higher up in the flank or the loin, or even up under the liver in the neighbourhood of the gall-bladder. Such an abscess will increase in size slowly and steadily and track in various directions.

If untreated an appendix abscess may absorb, burst into a neighbouring coil of bowel or hollow viscus, or more rarely burst externally, usually through the skin of the iliac fossa or the lumbar region, or occasionally may give way into the peritoneal cavity and lead to acute septic peritonitis; this last calamity is unlikely to occur unless an aperient or an enema is administered.

When such an abscess is present it is not uncommon to find a certain amount of serous exudate of a non-infective nature lying free in the peritoneum, and all the tissues in the neighbourhood of the abscess will be boggy and œdematous.

(c) In those serious cases where there is no localisation, a rapidly-spreading, *diffuse, septic peritonitis* occurs, which ultimately involves the whole peritoneal cavity. The pathology of this is fully described on pp. 531, 532, while the way in which the pus tends to track and the infection to spread, owing to the anatomical structures and watersheds, is described on p. 510.

(d) Infection or suppuration occasionally occurs outside the peritoneum in the *retroperitoneal tissues.* This is most common with a retrocolic appendix, and takes the form of a cellulitis, which may spread downwards as far as Poupart's ligament, where the iliac fascia prevents it passing into the thigh or upwards towards the liver and subdiaphragmatic space. Suppuration will then occur in any of these situations, though in many instances a large mass of solid œdematous, cellulitic tissue forms, containing very little pus. In time such an abscess may reach actually into the thorax, the perinephric region, or, by entering the psoas sheath, may track down into the thigh.

Various *complications* may follow acute appendicitis; they are those of intraperitoneal infection in general. Thus *femoral thrombosis* is common; infection of and inflammation of other organs close to or in contact with the appendix, such as the ovary or the Fallopian tube, are not uncommon; infection of the kidney and pyelitis are occasionally seen, while, as the result of a spreading thrombosis of the appendicular veins, *portal pyæmia* or *pylephlebitis* may arise. Rarely *gas gangrene* occurs from infection of the psoas in retrocæcally placed appendices and this may spread either into the thigh or into the abdominal wall. This condition is nearly always fatal, but should receive early energetic treatment. Intestinal obstruction will result sometimes from the bands and adhesions formed. Occasionally an appendix lying in a hernial sac becomes acutely inflamed; the pathological changes are then exactly similar, save that, being localised within the hernial sac, there is little likelihood of involvement of the general peritoneal cavity (see also Chapter XIV., p. 563).

CLINICAL TYPES OF ACUTE APPENDICITIS

In the following account of the various clinical types of appendicitis it must be remembered that they are all stages in the same process, whose appearance will depend largely on the duration and virulence of the disease.

The clinical features of acute appendicitis depend so largely upon the stage which the disease has reached, upon the amount of involvement of surrounding tissues, and upon the position of the appendix, that a wide variation in them will be observed. For descriptive purposes we shall consider acute appendicitis under the headings of (1) acute catarrhal appendicitis; (2) acute appendicitis with local peritonitis; (3) acute appendicitis with general peritonitis; and (4) acute appendicitis with abscess formation.

(1) **Acute Catarrhal Appendicitis.** This is the mildest form of the disease, in which the inflammation remains confined to the appendix itself, and does not involve the surrounding peritoneal tissues. It is the early stage of all the different forms of the disease, but in severe cases the progress is so rapid that this early stage is not likely to be observed.

A typical attack commences with the fairly sudden onset of pain, situated in the epigastrium or round the umbilicus at first, increasing in severity for some hours, often commencing in the small hours of the morning, and not usually the result of any violent movement, strain, etc. This may be of one of two distinct types :

(*a*) *Colicky* and due to definite obstruction of the appendix lumen by a fæcolith (composed mainly of inspissated soaps) trying to pass a stricture or a kink usually caused by external adhesions nearly always consequent on previous appendicular trouble, a history of which can be usually elicited.

(*b*) *A dull ache* associated with the milder catarrhal inflammation where the lumen is generally patent and if a concretion is present no obstruction is offered to its passage. In this type gangrene and perforation are far less likely to occur.

After twelve hours the pain generally passes down towards the right iliac fossa, where it remains. It is of an aching or throbbing character and commonly continuous, though spasmodic exacerbations occur. Soon after the onset of the pain, nausea, malaise and vomiting commonly set in, though the latter is often slight, while a slight rise of temperature will occur, usually not reaching above 99° to 101° F. This syndrome of pain, vomiting and rise of temperature in this order is sometimes referred to as *Murphy's syndrome of appendicitis.*

Coincident with the rise of temperature, the pulse begins to rise to 90 or 100, while if any obstruction of the appendicular lumen is present the pain occasionally will be griping and colicky (*appendicular colic*). Constipation is usually present, though occasionally, especially in children, there may be diarrhœa at the commencement. A few cases are preceded by a sore throat.

On examination the patient will be found lying on his back or right side with the right leg drawn up. He looks ill, his tongue is furred and dirty, and usually he does not complain of headache. There is a certain amount of *rigidity of the muscles of the abdominal* wall on the right side and in the right iliac fossa, and the more marked this is, the more severe the attack, while the respiratory movements of the lower part of the abdomen are limited. There is definite tenderness in the right iliac fossa, and this is usually most marked at *McBurney's point,* which is on the line joining the umbilicus to the anterior superior spine, and one-third of the distance from the latter point.

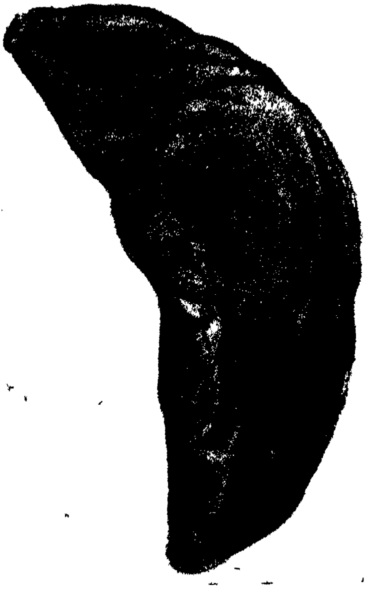


FIG. 253. Gangrenous appendix with a large concretion in it.

In many cases an area of hyperæsthesia of the skin will be found in the distribution of the twelfth dorsal nerve, and lying roughly over the site of the appendix itself; this is said to disappear if the appendix perforates. In mild cases it will be noticed sometimes that the cæcum is palpable, distended and gurgling, and the descending colon empty and in spasm, while a useful sign in very mild cases sometimes consists in the fact that pressure upwards on the left side of the abdomen causes pain in the neighbourhood of the appendix. This may help to distinguish the condition from pain of renal origin.

If the appendix lies behind the colon or in the pelvis, the features will be very different. In the first case, all the symptoms are slighter and the progress is usually slow; thus the pain and tenderness will be higher up, tenderness often only being marked in the loin and pain in the epigastrium, while the rigidity is much less marked. Peritonitis is not likely to occur, but retroperitoneal cellulitis and abscess formation are common, and an ill-defined swelling will form slowly in the loin. A description of pelvic appendicitis is given below.

In a few cases it is found that severe pain is referred to the right testicle. This may be the result of the appendix lying on the ureter or spermatic vessels.

It cannot be insisted upon too strongly that any of the signs or symptoms described above, except tenderness over the appendix, may be absent; *pain and tenderness over the appendix wherever it may lie are the two essential symptoms*, though the tenderness may be elicited only by rectal examination.

This mild form of the disease usually progresses for twenty-four or forty-eight hours, and then, if properly treated, may settle down and pass off without either abscess formation or peritonitis. Either of these grave complications, however, may arise in any case, and it is impossible to foretell whether they are going to do so or not; the rapidity and severity of progress cannot be foretold. After the attack has passed off it leaves behind it adhesions and an appendix which is fibrosed, strictured and possibly obliterated. Should a definite lump be felt (see p. 712), it is evidence that the disease has spread outside the wall of the appendix.

In elderly people it should be remembered that the alteration in pulse and temperature is not usually marked, while in children the reverse holds good, and pulses and temperatures run high.

Pelvic Appendicitis. This is a common form of the disease, where owing to the position of the appendix in the pelvis the signs and symptoms may be puzzling. Any of those described above may be present, but rigidity and tenderness are slight, and tenderness and pain are often as marked on the left side as on the right. In some cases no tenderness will be detected at all until the rectum or vagina is examined, when a definite tender spot and even the appendix itself may be felt. In addition, frequency and pain on micturition are common, while tenesmus and mucus in the stools are occasionally seen. The pain sometimes shoots down the right leg, and movements of the right hip which tend to stretch the obturator internus muscle are painful.

In a few instances the tip of the appendix is adherent to the bladder or ureter, and then urinary symptoms in the form of frequency, strangury and pain at the tip of the penis will be marked. In every possible case of appendicitis the rectum should be examined.

If an abscess forms this will lie in the pouch of Douglas, where it can only be detectable on rectal or vaginal examination.

In nearly every case of abdominal infection where definite intraperitoneal inflammation is present it will be found that on percussion the liver dulness is raised to the extent of one rib or more, owing to deficient function of the diaphragm. This, however, does not occur in pelvic appendicitis. The tendency to peritonitis, at first confined to the pelvis, and to the formation of a pelvic abscess is great.

The differential diagnosis of acute appendicitis is discussed later in this chapter.

Treatment. This is discussed on p. 713.

(2) **Acute Appendicitis with Local Peritonitis.** This is a more severe form of the disease, and is usually the result of catarrhal appendicitis which has been advancing for twelve hours or so, so that the peritoneum in the neighbourhood of the appendix is becoming inflamed; this may, or may not, be associated with gangrene or perforation of the appendix.

When seen after local peritonitis has set in, the patient's pain will be more severe and entirely in the right iliac fossa and lower part of the abdomen, spreading across towards the left side. Pain, tenderness and muscular rigidity are all marked, especially on the right side, and abdominal respiratory movements will be limited. Vomiting occurs more often and abdominal distension, with the presence of a dull note to percussion in the right iliac fossa, will be noted frequently, while the pulse will rise above 100 and the temperature remain at 99° or 100°. All the signs and symptoms are still, however, more marked on the right side of the abdomen. On auscultation, absence of peristaltic sounds will be noted in the right iliac fossa (see p. 534). We must again insist on the fact that the temperature is of very little help in diagnosing appendicitis. It is never very high and often normal. If the temperature rises above about 101° the condition is not likely to be appendicitis except in the case of young children.

It is after this local peritonitis has set in that a palpable mass may begin to form around the appendix, though it is not likely that any lump will be felt until the disease has been present for forty-eight hours. Such a lump consists of the structures round the appendix, which are inflamed, infiltrated, œdematous and matted together with lymph. It will be tender and fixed, doughy and rounded in shape and occurring in whichever situation the appendix is lying. It may be dull or tympanitic on percussion, according to the amount of bowel or solid tissues forming it; while on many occasions it can be felt only on rectal examination. If not properly treated, such a case is very likely to go on to the formation of a local abscess (see p. 712), while not infrequently a general peritonitis will set in. The presence of a mass of the type described above renders the likelihood of general peritonitis very much less. It is, however, exceedingly likely to lead to abscess formation, though in few cases treated by expectant measures such a mass may begin to subside after the fifth or sixth day. After twenty-four hours leucocytosis probably will set in. For the treatment, see p. 713.

(3) **Acute Appendicitis with General Peritonitis.** This is the most grave and fatal form of the disease; though not infrequently it results in a case which, though mild at first, has been improperly treated for two or three days, it often sets in suddenly without any preliminary warning (**fulminating appendicitis**). It is especially common in children and in patients where, as the result of strictures, kinking or fæcoliths, sudden obstruction of the appendix with distension of its lumen occurs. There may or may not be a history of previous milder attacks, but frequently we shall be told the patient has had " bilious attacks " or attacks of " colic."

The onset is sudden, the pain intensely severe, vomiting is marked and progressive, and the patient may become collapsed; one or more rigors may occur. The patient rapidly becomes alarmingly ill, and though for a short time the signs and symptoms may point to the right iliac fossa, the features of diffuse general peritonitis described on p. 532 soon set in. It is indeed probable that in such cases the first onset of pain coincides with actual perforation. In other cases, after a few hours the pain becomes less severe, though the other signs and symptoms progress, and this is almost certain evidence that gangrene or perforation of the appendix has occurred. *Immediately after gangrene or perforation has occurred, in addition to diminution of pain, the rigidity may disappear and the temperature become subnormal for a short time, though the pulse remains rapid.*

The most striking symptoms in such a case are the amount of rigidity, vomiting, rapidity of the pulse and the rapid downward progress of the patient. On rectal examination the whole rectal wall may feel hard and tender. If untreated, the condition will prove fatal within two or three days.

The possibility of the lumen of the appendix being obstructed by kinks, concretions or fæcoliths is of great importance, for when **appendicular obstruction** is present the case is far more urgent and severe. Vomiting is more marked and perforation more rapid. In such a case there is often a preliminary bout of severe griping pain and vomiting and then a period of reaction when the pain gets much less. But this often means that perforation has occurred and that peritonitis of a virulent type has already started.

Treatment. This is discussed on p. 713.

(4) **Acute Appendicitis with Localised Abscess (Appendix Abscess)** (see also Chapter XIII., p. 542). In most cases this may be regarded as an extension of type (2), where local peritonitis has occurred, spread to a certain degree, and a mass has been formed, within which suppuration and abscess formation occur. The organisms causing the suppuration are therefore those from the bowel; they may have passed through the inflamed appendicular wall, or in many instances there will be a perforation into an area shut off by adhesions. It is most unlikely that an abscess will form until the disease has been present at least three days, while once it has formed its progress is usually somewhat slow, though there is always considerable risk that, if not properly treated, general peritonitis may set in as the result of the abscess leaking, or obstruction may result from the adhesions it causes. When an appendix abscess is present there usually will be a history of two, three or more days' illness pointing to appendicitis, the symptoms often being somewhat vague. The patient will then be found to have a somewhat high, swinging temperature of 102° or 103°, though in some very chronic cases it will be normal. The pulse rate will be raised, the patient will look ill and toxic, with a dirty tongue and constipation. Distension and tympanites are present, while a round, tender, firm swelling with rigid muscles over it will be detected. This may be in the pelvis, right iliac fossa, the loin, or even the hypochondrium, according to the position of the appendix, and it may be dull or more often tympanitic. It will be fixed, but probably fluctuation will not be detected: indeed, it should not be sought for. Leucocytosis will be present and the swelling will increase slowly in size, becoming softer and more tender. In the case of an inflammatory mass in the iliac fossa or at the brim of the pelvis (whether due to appendicitis or other causes) it may be noticed that pressure on the femoral artery in Scarpa's triangle sufficient to stop the circulation will cause pain or increase of pain in the mass. This is the

result of increased pulsation in the iliac vessels. If the mass is untreated and increasing, several things may happen: general peritonitis or obstruction may supervene; the abscess may burst into the bowel, especially into the rectum, and this, though not desirable, may be followed by cure. Such a pelvic swelling will be detectable from the rectum, and when it is pointing and going to burst there, the rectal mucous membrane will feel adherent, œdematous and boggy. When a pelvic appendix abscess is present, there is frequently tenesmus and mucus in the stools. In other cases the abscess will burst into the bladder or vagina, or track up along the line of the ascending colon towards the liver; while in other neglected instances it will approach the surface and burst on the abdominal wall, giving rise to a sinus or even a fæcal fistula. This is preceded by redness, increase of dulness over the swelling, œdema of the abdominal wall and dilatation of cutaneous veins.

In some instances, after the first onset of symptoms, an improvement occurs and most of the signs and symptoms disappear, though some one sign or symptom may remain; after a few days there is an increase of pain and other symptoms, and on examination a characteristic abscess in one of its recognised situations will be discovered.

It should be remembered that rectal examination is essential in all cases of appendicitis. The differential diagnosis of an appendix abscess is somewhat different from that of appendicitis in general in that the presence of a swelling has to be considered. It will be discussed on p. 724.

For the differential diagnosis of acute abdominal diseases, see p. 721.

Treatment of Acute Appendicitis. Many different views have been expressed on this subject, for whereas there is little doubt that it is quite impossible in the first stages of the disease to foretell which cases are going to recover spontaneously, which are going to perforate, which are going to become gangrenous, and which are going to lead to an abscess, it is equally true that an ill-timed operation, performed when localisation is just occurring and the infection is beginning to settle down, is likely to spread the infection, set up peritonitis, and possibly even lead to the patient's death.

There is, of course, no specific medical treatment for appendicitis; general treatment such as rest in bed and the avoidance of anything, especially purges and enemata, likely to make the condition worse is all that can be done.

Our own practice (and that of a rapidly increasing number of medical schools) is always as follows: (*a*) *in all cases where the condition has been present for less than forty-eight hours, immediate removal of the appendix is advised.* At this period few adhesions and no mass have been formed, and the appendix can be removed as easily and with as little risk (provided perforation has not already occurred) as in the quiescent state when no inflammation is present. By adopting this attitude there is no doubt that appendices will be removed from certain patients who would have recovered without the operation, but their recovery is hastened thereby, and as, after recovery from an attack of appendicitis, they certainly will be advised to have their appendix removed at a later date, a great deal of time is saved all round; while, on the other hand, by immediate operation, many lives are saved and much illness averted, as it is impossible to tell which cases will go wrong if not operated upon. Abscess formation and peritonitis by this method will be avoided.

(*b*) When a patient is seen who has been ill for more than forty-eight hours, *i.e.*, during the third, fourth and fifth days of the disease, considerably more judgment is required. A lump is then probably forming, which may be beginning to contain pus, and localisation is occurring. Operation, therefore, should be avoided at this period if possible. We advise, therefore, during the third, fourth and fifth day that if the patient's condition is improving or remaining stationary operation should be deferred; if, however, the condition is in any way progressing as shown by increase of pulse rate, vomiting, pain, tenderness, distension or spreading of the area of tenderness, pain or rigidity, immediate operation should be performed. Rise of pulse rate is especially important in this connection.

In these cases if operation seems necessary also our intention would be to remove the appendix, but in some instances where a hard mass is present and the appendix is buried in adhesions it will be wiser not to remove the organ, but to be content to pass a tube either down to the collection of pus, if present, or down to the hard mass, to form a track up which the pus can escape (cœliotomy, see p. 542).

(*c*) After the fourth and fifth days the condition will be either improving and the patient recovering, in which case operation can be withheld, or else an abscess will have formed or be forming, and the treatment will be that of an appendix abscess (see p. 715).

(*d*) In those cases where rapidly spreading or general peritonitis is obviously present, immediate operation should be performed and the appendix removed if possible. It must be stated, however, that at one large London hospital at least it is held that, when general peritonitis is present, better results may be obtained by delaying operation for a few days in the hope that localisation of the infection may still occur.

With regard to the question of drainage in operations for acute appendicitis, opinions vary. There is, of course, no question of drainage if the appendix is unperforated and there is no pus in the peritoneum. When local or general peritonitis is present and the appendix can be removed there is probably no need for drainage either, though many surgeons prefer to insert a tube into the pouch of Douglas for a few hours (Chapter XIII.).

Certain surgeons and medical schools hold different views with regard to operation in acute appendicitis and advocate that in every case, and at all stages of the disease, whether an abscess is present or not, the appendix should be forthwith removed. With this we are totally in disagreement.

In those cases of acute appendicitis where for any reason operation has not been performed, or which are being watched with the possibility of operation, careful general treatment must be given. The patient must be kept in bed in the Fowler position and hot pads or fomentations applied over the lower abdomen. The pulse rate should be taken hourly. *No aperients should be given,* and even soap and water enemata should be avoided unless distension becomes very marked. The lightest possible diet should be given, and it should be entirely fluid, while in most cases nothing but hot water should be allowed for the first twenty-four hours. If vomiting is severe, fluid may be administered by the rectum. Morphia and opium derivatives should be avoided if possible unless operation is quite and permanently out of the question, for they will mask the symptoms and make the patient appear better than he really is.

After a definite attack of appendicitis has passed off without operation, and still more after second and third attacks, the patient should be advised strongly to have the appendix removed at a convenient period, usually in about eight to twelve weeks; by this time adhesions will be absorbed (see Chapter XIII.). For recurrence is common, and the popular superstition that the first attack is likely to be the worst has nothing to support it; at any moment he will be liable to get a severe attack with perforation. The more attacks he has the more adhesions will be formed, and appendicectomy will become more difficult, while the adhesions may even give rise to obstruction. After an acute attack chronic appendix dyspepsia (see p. 717) is likely to follow.

For the details of the operation in acute appendicitis, and the complications which may follow, see p. 720.

Treatment of Appendix Abscess. An appendix abscess is not likely to arise until the disease has been present some days, and it is evidence that satisfactory localisation has occurred. Operation is, therefore, not a matter of such grave urgency as in some of the earlier cases. A lump will be felt, and if it is thought that the abscess has not reached up to the peritoneum of the anterior abdominal wall, it will be wise to delay opening it for a few hours or a day or two to allow it to increase, and come into contact with the anterior abdominal wall, as thereby it can be opened without traversing the free peritoneal space. An indication of its reaching up against the anterior abdominal wall will be given by noting that the swelling is becoming more flattened and more dull to percussion, and the tenderness more marked. Big abscesses, on the other hand, should be opened without delay.

To open an appendix abscess the incision is made over the most prominent part of the swelling, and usually will be of the muscle-splitting variety (see p. 719). The layers of the abdominal wall are incised carefully, and as the peritoneum is approached œdema will be noticed. When the peritoneum is opened a blunt instrument or the finger may be inserted gently into the abscess and foul pus will flow out.

On the other hand, if on opening the peritoneum a free space is encountered and the abscess is found to be some little distance away, it must be packed off carefully with gauze plugs to protect the peritoneum before it is opened. The pus is mopped out and a drainage tube inserted. A cœliotomy (see p. 542) is more often advisable in this case, for it diminishes the risk of peritonitis. We feel that it is wise to do no more in the case of an appendix abscess, and that unless the appendix is definitely presenting under the wound, no attempt should be made to strip the adhesions apart in order to remove it, for this carries with it grave risks of causing a general peritonitis. In most cases the drainage track will close in from ten days to a fortnight, and the patient should be advised to have his appendix removed in about three months to prevent further attacks. In a few instances the sinus will refuse to close, and this is probably due to the presence of the chronically inflamed appendix, or possibly of a concretion which has escaped from it lying at the bottom of the wound. In this case appendicectomy will cause it to heal.

If on rectal examination it is found that the abscess is pointing into the rectum, it may be opened here by means of a blunt instrument, when satisfactory healing will occur. By pointing into the rectum we mean not that the abscess can be felt from the rectum, but that the rectal mucous membrane over it is fixed, boggy, œdematous and very tender.

A few small and hard appendix abscesses will be found to settle down and disperse without operation, but it is hardly ever wise to count on this, as there is considerable risk of the patient becoming obstructed by the adhesions. Appendicectomy should be undertaken subsequently in *all* cases, usually in about three months, when generally the adhesions will have largely disappeared.

Special Classes of Patients. There are certain aspects of acute appendicitis as seen in particular types of people which are worthy of comment.

(*a*) *In Children.* In children over the age of two this disease is very common, but it is rare before this. It tends to be very severe, and perforation and general peritonitis are frequent and rapid sequels. The commonest age for its occurrence is undoubtedly between the ages of six and fifteen, when both general peritonitis and abscess formation are frequently seen.

The signs and symptoms in small children are notoriously misleading. Pain may be slight, but vomiting is usually marked, and the temperature may run high. Examination is often difficult, but the one cardinal symptom of tenderness over the appendix is nearly always present. In some children the only symptoms of a chronic appendix seem to be that they occasionally vomit, especially at night, without obvious cause, while they will complain at times of fleeting abdominal pains. The urgency of operation in a child is even greater than in an adult. In subacute cases, spasm of the psoas with flexion and internal rotation of the hip may give rise to a resemblance to hip disease.

In girls at puberty who are commencing their periods for the first time there may be pain and tenderness across the lower abdomen which are misleading, but there is no vomiting or rise of temperature or definite local tenderness.

(*b*) *Appendicitis in Pregnant Women.* This is a not uncommon occurrence, and is not unnaturally serious. In the early months the diagnosis is straightforward, but a miscarriage is likely to occur, whereas in the later months the size of the uterus and displacement of the bowel confuse the diagnosis, as the probability of pyelitis on the right side has always to be considered. The urgency of operation is great, for perforation and peritonitis are likely to occur, while the risk of miscarriage is one which must be faced.

(*c*) *Appendicitis in Stout People.* In stout persons, appendicitis tends to form pus early, and rapid and severe forms of suppuration occur. A mass may be difficult to feel and it must be remembered that stout patients show less rigidity and run a lower temperature than do thin ones. It is therefore wise to assume that any case of appendicitis in a stout patient is really more severe than it appears to be clinically.

(*d*) *Appendicitis in the Elderly.* After the age of fifty, though the appendix tends to shrink up and disappear, the disease is still not infrequently seen. We have recently seen patients of eighty-eight and ninety-one with perforated appendices. When the disease occurs in elderly patients, especially if they are stout, it takes a severe form ; suppuration and peritonitis are common and abscesses are often seen, while the patient's general powers of recovery are much diminished. The diagnosis is not usually straightforward, as it must be remembered that in elderly patients there is much less rise of temperature and pulse rate than in the young, while abdominal rigidity is often absent. Occasionally in the elderly a peculiar form of appendicitis is seen where the pain and symptoms continue for ten days or more without much other change. No mass is formed and no peritonitis sets in. A gangrenous appendix will then often be found without adhesions or peritonitis round it.

Gangrene of the appendix sets in early in the aged.

(B) RECURRENT APPENDICITIS

Once a patient has had an attack of appendicitis, whether mild or severe, he is undoubtedly likely to get others at a future date, which may be more or less severe than the initial one. This is especially likely to occur after the patient has had an appendix abscess. In some cases these attacks are so frequent that the patient is hardly ever well in between them, while each attack further damages the structure of the appendix itself. Sometimes the appendix appears to become attached to the psoas muscle, so that excessive movements of the leg cause pain and are liable to light up an attack, while in other instances, and especially where strictures and fæcal concretions are present, the patient suffers from frequent, short-lasting, severe attacks of abdominal colic without fever or vomiting (**appendicular colic**). It is possible after many years, in some instances, that the appendix becomes completely fibrosed and obliterated, but this is undoubtedly very rare ; it constitutes a spontaneous cure.

A few cases are seen in which apparently a slight attack never seems to pass off completely, or improves up to a certain point and then some feature will again become more marked, such as slight rise of temperature, tenderness or pain, and this condition may go on for weeks. This well may be called *relapsing appendicitis*, and leads to much ill-health.

The only treatment for all these subacute conditions is removal of the appendix. This often will be a difficult operation on account of the adhesions which will be present.

Upon removal various pathological states of the appendix will be encountered. It may be white, fibrosed and partially obliterated, or thick, firm and red from fibrous infiltration ; fæcal concretions, strictures, and kinks may be present. It may be distended in whole or part into a mucocele, or one or more diverticula may be found in its wall, while it may be discovered to be adherent to nearly any of the abdominal organs.

(C) CHRONIC APPENDICITIS

Though the previous conditions may be regarded as chronic forms of appendicitis, the above term should be reserved for a somewhat different condition, also known as **appendicular dyspepsia.** Here the patient may have had nothing resembling an acute attack of appendicitis, but most of his signs and symptoms are chronic, and are referred to the gastric and epigastric regions. He complains of tiredness, weakness, indigestion and epigastric pain or general abdominal discomfort with very little relation to the right iliac fossa ; constipation and flatulence are marked, and there is usually definite tenderness in the right iliac fossa. The pain is in no way so definitely related to meals as that in the case of gastric or duodenal ulcer, though it may somewhat resemble the latter. In these instances an opaque meal sometimes will show the outline of the appendix, and that it is strictured or kinked. The condition is frequently associated with a chronically inflamed retrocæcal appendix, which may be adherent to the duodenum behind the cæcum and colon, and all symptoms completely clear up when this is removed. This condition must not be confused with a more or less continuous dull aching pain, persisting for months and years in the right iliac fossa, of which some patients, especially women, complain. Here a large, tympanitic, gurgling cæcum will be felt, and this *distension of the cæcum* with wind is the cause of the pain.

It is probable that certain forms of chronic appendicular infection are responsible in some instances for gastric and duodenal ulcer, colitis, osteoarthritis, arthritis in children, etc.

With regard to appendicitis in general, we would like to take the opportunity of warning the enthusiastic but inexperienced surgeon of the pitfalls which may lie in wait for him. In the first place, removal of the appendix may be the easiest operation in surgery; it also may be the most difficult, while we would point out also that every patient who has a chronic pain in his abdomen will not be cured by removal of his appendix. Nothing is more common than to see patients, who have had their appendices removed (usually through small gridiron incisions, of which they are very proud), who are really suffering from duodenal ulcer, spinal caries, or diseases of the kidney or gall-bladder, all of which might have been avoided had the maxim that every abdominal operation should be an exploration been observed. " Lives are lost by muddling inside the peritoneum on the part of those whose experience is small " (R. Warren).

Tuberculosis of the Appendix. This is not uncommon in tuberculous patients, especially those who are phthisical. Though the infection is confined to the appendix in early cases, it is far more common to see it as part of a generalised hyperplastic ileocæcal tuberculosis, as described on p. 665. In other instances the appendix is involved as part of a generalised tuberculous peritonitis. The symptoms are those of chronic appendicitis in general, and the condition is hardly ever recognised until the cæcum is involved and a palpable mass can be felt. The treatment in the early stage consists in removal of the appendix; later cases will have to be treated as described on p. 666.

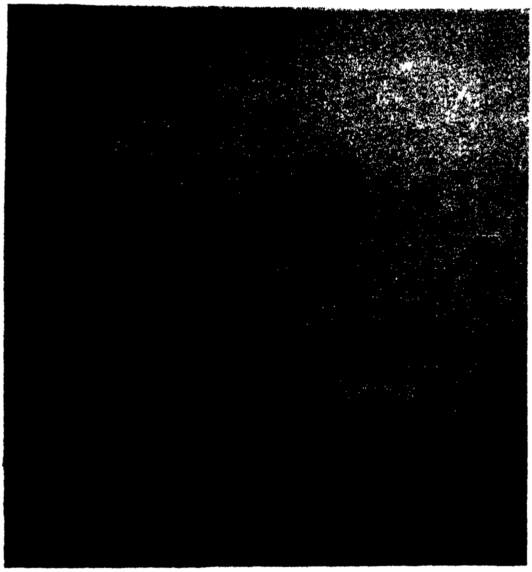


FIG. 254. Actinomycosis of the appendix and cæcum involving the liver and abdominal wall and causing multiple sinuses in the loin.

Actinomycosis of the Appendix. This is by no means rare, the appendix and cæcum being the second commonest place in the body for this disease to occur. The infection gets in from the lumen through the mucous membrane, and spreads to the muscular wall and peritoneal coat. In time the cæcum, ascending colon and anterior and posterior abdominal walls become involved, and are fused into a hard, wooden-like, fixed mass. Suppuration occurs and multiple sinuses appear, discharging the characteristic sulphur granules. The discharge has a peculiar, musty smell, and the streptothrix can be found within it. It is by no means uncommon for this state of affairs to occur after an operation for acute appendicitis or appendix abscess. The wound refuses to heal and a sinus persists, while in the course of the next three or four months a densely hard, fixed, painless swelling appears and other sinuses break out. The condition may resemble malignant disease or tuberculosis, but is more chronic.

The treatment consists in the general methods adopted for actinomycosis. Little can be done in the way of operation, as the mass is usually too big and fixed, and the appendix often has been removed already. Large doses of potassium iodide or sulphanilamide should be given by the mouth, and favourable results have been reported from the administration of iodide in milk. Injections of 4 per cent. formaldehyde or 1 per cent. copper sulphate solution may be given. Radium therapy by external application from a bomb or deep X-rays has given good results lately, but care is needed in dosage or the cæcal and abdominal walls may slough. The outlook is, however, bad; the disease spreads slowly to the liver and other tissues, suppuration continues, and lardaceous disease sets in, followed by death.

Carcinoma of the Appendix. An unusual form of primary malignant disease is not uncommon in the appendix. It is a spheroidal-celled carcinoma of very low malignancy, which may occur at practically any age, especially in comparatively young people. It is thought that this condition may arise in certain palisade cells in the appendix. In some cases the symptoms are very vague, and the condition is discovered only on microscopical examination of the appendix after its removal, but at times it appears to predispose to an acute attack of appendicitis by obstructing the lumen of the appendix. To the naked eye it appears tough, yellow and solid, often forming a round hard lump in the end of the appendix as big as a marble. There is usually no glandular involvement and recurrence after appendicectomy appears to be rare, but it is possible that this is the undiscovered primary growth in certain cases which are thought to be primary carcinoma of the liver. More rarely a true columnar carcinoma or sarcoma is seen. This is of much greater malignancy.

OPERATIONS UPON THE APPENDIX

(1) Appendicectomy in a Quiescent Period. Many incisions have been advocated for this operation. The oldest incision, which is now quite out of date, was the *muscle-splitting incision of McBurney*, where a skin cut 3 inches long, approximately parallel to and 1 inch above the outer half of Poupart's ligament, was made. The abdominal muscles were then split in the direction of their fibres and the peritoneum opened. This had the advantage of lying directly over the appendix and of cutting no muscles; it had no other merits whatsoever and many disadvantages. It was quite impossible to enlarge it satisfactorily without damaging the muscles, and no examination of other abdominal organs could be made through it; moreover, it is much more painful than the other incisions. As soon as it was realised that there were very few cases in which a mere appendicectomy sufficed, and that in practically every case an examination of other abdominal organs should be made, this incision fell completely out of use, except for opening appendix abscesses. The practice of removing appendices through small 1-inch McBurney incisions, of which some surgeons boast, though it is quite easy, is a mark of a total lack of surgical balance.

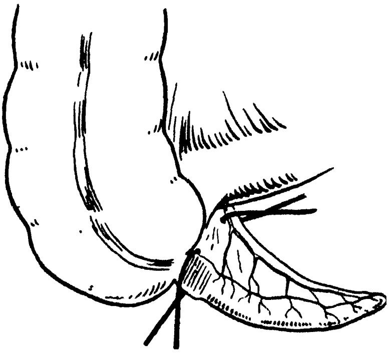


FIG. 255. Removal of the appendix. The mesoappendix is tied and the base of the appendix crushed and ligated.

Battle's incision has not much to recommend it. Here the incision is made parallel to the lower 3 inches of the semilunar line and ½ inch within it. The rectus sheath is opened and the muscle drawn in, the peritoneum being opened transversely. The abdomen can be explored fairly satisfactorily through this, and the incision can be enlarged, though if this is done it is probable that some of the nerves running to the rectus will be damaged, and for this reason really the best incision is the ordinary *paramedian incision*, the rectus being drawn outwards. A *transverse incision* is occasionally used.

After the peritoneum is opened the cæcum is sought for and drawn up into the wound, and the anterior longitudinal band followed down. This will lead inevitably to the base of the appendix. The appendix is then set free and drawn into the wound, its mesentery clamped and cut, and the organ completely isolated down to its attachment to the cæcum. The base of the appendix is then firmly crushed with a crushing clamp as close to the cæcum as possible, thus crushing out all tissue except the peritoneal coat, which is then ligatured. The appendix is then clamped above the ligature and cut off, care being taken not to soil the peritoneum. The stump of the appendix is invaginated, either by a purse-string suture or by the Z stitch, and the vessels in the mesentery are tied off. The abdomen is then closed. Some surgeons make a practice of placing a drop of pure carbolic upon the stump of the appendix before invaginating it; others do not invaginate the stump at all. The after-treatment is that of abdominal operations in general, and from ten to fourteen days in bed will suffice.

(2) **Appendicectomy for Acute Appendicitis.** The incision is made and the general procedure is the same as in the foregoing. On opening the abdomen the neighbourhood of the appendix should be carefully examined to see if any swelling or lump is present, and if so, the region of the appendix should be carefully packed off with two or three gauze plugs in case any pus is set free. Removal of the appendix will be much more difficult; there may be many adhesions, and the tissues will be boggy, œdematous and vascular. Great care must be taken in crushing the appendix, as if it is very infiltrated it may burst, while caution must be observed in bringing the appendix up into the wound lest it be torn or burst then. If the cæcum is very infiltrated or œdematous, it may be impossible to invaginate the appendix stump. If the tip of the appendix appears very adherent and difficult to reach, it will make the procedure easier if its base is separated from the cæcum first, the stump invaginated, and then the appendix followed down and removed.

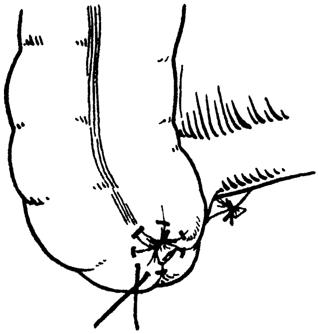


FIG. 256. Purse-string suture inserted to invaginate the stump.

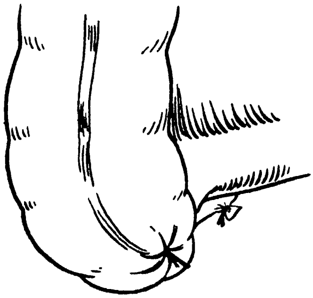


FIG. 257. Mesentery ligatured and stump invaginated.

Complications after Operation. Any of the complications which follow abdominal operations in general, such as pneumonia, collapse of the lung, peritonitis, etc., may occur after this operation; but as we are here dealing with a peritoneum in which some degree of infection is present, certain infective complications are especially likely. They are all exceedingly rare if the operation is performed within the first forty-eight hours of the disease. Thus *peritonitis* may occur after the operation as well as before it. This is described on pp. 531–541.

Paralytic ileus also will be seen (see p. 696).

True *organic intestinal obstruction* as a result of adhesions between coils of bowel is also seen occasionally, though in our experience this is very rare. In any case it is not likely to arise for at least a week, or even longer. The symptoms are those of obstruction in general, as described on p. 676. Further urgent laparotomy will be required.

Secondary abscesses are not uncommon in cases where pus was present at the original operation. They always should be suspected if, after a few days, the patient's temperature remains up or rises again, and are seen especially in the pelvis, the right or left iliac fossæ, or the subphrenic region. Above all, frequent examination of the rectum must not be neglected if such a condition is suspected. Such an abscess must be opened and drained, though there is as a rule no grave urgency about it.

Femoral thrombosis, especially on the left side, is not uncommon.

A *sinus* sometimes will persist at a spot where a drainage tube was inserted, and may be the result of a fæcolith which has been left behind, the tip of the appendix which may have sloughed off, or the presence of an infected ligature. After a time the causative agent is usually discharged, and the sinus then heals spontaneously.

A fæcal fistula is, unfortunately, not uncommon after appendix operations, and is seen in very septic cases where tubes have been employed. It is especially common in appendix abscesses, or where the wound has gaped considerably some days after the operation and possibly a coil of bowel has become exposed within its depths. It is due to leakage from the stump of the appendix or from a local necrosis of the bowel wall, and discharges semiliquid fæces, usually through a long track. Unless properly protected by ointment, the skin round it rapidly will become sore and red. Nearly all these fistulæ will close spontaneously in a week or two, but in some instances operative treatment will be required. The coil of bowel is exposed, separated from the abdominal wall, and closed with two layers of sutures. The abdomen is then closed in layers over it. In a few instances a resection of the coil of bowel will be necessary.

Portal pyæmia or pylephlebitis is a rare but highly fatal complication (see p. 736). There is a high swinging temperature, with rigors, abdominal pain, and distension and vomiting. The spleen and liver rapidly become enlarged and tender.

A *ventral hernia* is sometimes seen after this operation, especially if drainage has been employed and the wound has become septic. It is, however, very rare after the Battle or paramedian incisions. This is described on p. 605, where its treatment is also dealt with. Should the appendix not already have been removed, the opportunity should be taken, when a ventral hernia is operated upon, to eradicate it. Right inguinal hernia sometimes appears after operations for appendicitis. *Cystitis and pyelitis* are occasionally seen as complications.

(3) **Appendicostomy.** This is an operation which is occasionally performed to obtain drainage of the cæcum, or more often to provide a means of washing out the colon in colitis or dysentery. In this operation the McBurney incision is undoubtedly the best. The appendix is found, brought up into the wound, and drawn up so that an inch or two of it hangs out on to the skin. The wound is then closed round the appendix, which is fixed in place by one or two stitches. When lavage is required the tip of the appendix is cut off, a small rubber catheter is inserted, and the necessary washing out is performed. When the lavage is no longer required the appendix is removed.

THE DIFFERENTIAL DIAGNOSIS OF ACUTE ABDOMINAL DISEASES

The causes of the various acute abdominal diseases are many and may be grouped for diagnostic purposes under the following headings :—

(1) **Inflammations** : appendicitis, acute cholecystitis, acute salpingitis, diverticulitis, pancreatitis, or peritonitis.

(2) **Obstructions** : due to strangulated hernia, intussusception, volvulus, internal strangulation, bands, growths, gall-stones, mesenteric thrombosis, fibrous stricture of the bowel, etc.

(3) **Perforations** : of gastric or duodenal ulcers, tuberculous, typhoid or stercoral ulcers.

(4) **Hæmorrhages and torsions** : such as ruptured ectopic gestations, ruptured blood cysts of the ovary, twisted ovarian cysts or fibroids, torsion of the omentum or of the gall-bladder, etc.

Several other conditions may resemble these : Dietl's crises, the crises of tabes, colic (lead, renal and biliary), acute pneumonia, diaphragmatic pleurisy, acute pneumothorax, abdominal influenza, typhoid, Henoch's purpura, coronary thrombosis, constipation, uræmia, pyelitis, etc.

THE INVESTIGATION AND EXAMINATION OF ACUTE ABDOMINAL CASES

Special attention must be paid to :—

(A) **The age, sex, occupation and history** :—

(1) *Of previous illnesses,* similar attacks, or slighter symptoms, such as dyspepsia, pain after meals and how soon after, hæmatemesis, flatulent indigestion, melæna, constipation, diarrhœa, with mucus or blood, jaundice, disorders of micturition, frequency, hæmaturia, painful micturition, urgency, menstrual troubles, vaginal discharge, or a previous operation.

(2) *Of the present illness,* with special reference to the onset and the order of appearance of the symptoms.

(B) **The pain** : whether it is continuous, griping, stabbing, burning or aching ; whether it came on suddenly or gradually and whether it shoots up or down, through to the back or elsewhere, whether it came on during the night or the day, or before or after a meal, where it was at first and where it is now, whether it causes the patient to writhe about or keep still, and whether rest or movement relieves it.

If it is very sudden and severe it suggests perforation, hæmorrhage, torsion or strangulation ; if it is of gradual onset, rapidly becoming severe, it is probably due to colic of various types, obstruction or inflammatory conditions; if intermittent, it suggests colic, obstruction and especially intussusception.

(C) **The vomiting** : whether it is frequent or only occurred once.

N.B. One bout of vomiting at the commencement of any illness is of no significance in diagnosis.

Whether it is accompanied by nausea or retching, or whether it is effortless. The nature of the vomitus should be inquired into, whether it consists of food, or is bilious, green, brown or fæculent and evil-smelling. Though vomiting as an initial symptom may occur in almost any disease and mean nothing, when it is persistent and incessant, and is dark or brown, it is highly suggestive of peritonitis or obstruction.

(D) **The pulse and temperature** : these are considerably modified at first by the shock or collapse which is usually present at the beginning of acute abdominal conditions, and there, therefore, may be a slow, hard, wiry pulse at the beginning and a subnormal temperature. Later both pulse rate and temperature will rise to varying degrees. Though pulse and temperature give no indication whatever as to the nature of an acute abdominal disease, they are valuable indications of its presence.

(E) **The condition of the bowels** : constipation is usually present, but there may be diarrhœa with or without mucus and blood.

(F) **The examination of the abdomen,** noting movements on respiration, distension, local or general, visible coils of bowel and peristalsis, retraction, rigidity, local or general (especially whether this rigidity is constant, or gives way with each respiratory movement), tenderness and the presence of a *palpable swelling,* noting its shape, size, mobility, tenderness, consistence, outline and percussion note. Rigidity of the diaphragm may be shown by indrawing of the abdomen during respiration, or of the psoas muscle by flexion of the hip. See whether such a swelling, if present, has the characteristics of a renal, splenic, ovarian or gall-bladder tumour. Such swellings in acute abdominal conditions may be due to ovarian cysts, renal, splenic or gall-bladder lesions, intestinal growths, intussusception, volvulus, internal strangulation, appendicitis, appendix abscess, pyosalpinx, acute pancreatitis, or to the distended bladder.

Percuss the abdomen carefully, noting any areas of dulness, resonance or hyper-resonance (tympanites), shifting dulness in the flanks and suprapubic region (which is a sign of free fluid), or diminution or loss of liver dulness. (This is a sign of free gas in the peritoneum or of a distended colon.)

Auscultate the abdomen to see if peristaltic sounds are present or not, or whether they are increased in activity.

(G) **Examine the pelvis per rectum or per vaginam**: swellings in the pelvis, tender areas, ballooning of the rectum, and fixity of the pelvic organs should be looked for. Growths of the rectum or intussusceptions may be felt unexpectedly by this means. In examining the rectum the patient should be asked to try and distinguish between tenderness and discomfort at the sphincter when the finger is introduced, and pain higher up in the abdomen. The latter is, of course, the important feature.

(H) **The progress of the case** : rapid increase of symptoms within one or two hours, especially of pulse rate, rigidity and distension, shows that there is a serious visceral lesion, while steady increase of vomiting and distension denotes obstruction or peritonitis. Improvement in the general condition, together with a rising pulse rate, suggests hæmorrhage.

(I) In all cases **the urine, chest, nervous system, and the teeth** should be examined for evidence of renal colic, acidosis, pyelitis, pneumonia, diaphragmatic pleurisy, tabes, or blue line (lead colic).

N.B. (1) In every acute abdomen examine the hernial orifices.

(2) Acute abdominal diseases (with the exception of acute cholecystitis) do not, as a rule, have a temperature of higher than 102°, and often the temperature is subnormal, but the pulse rate is always raised except in the early stage of " shock."

(A) INFLAMMATIONS

As a rule, these have a gradual onset, taking a few hours, a rising pulse rate, rigidity, local or general, more or less rise of temperature, stabbing or aching pain of a continuous nature and a liability to pass into general peritonitis.

(1) **Acute appendicitis** is commonest in young people and gives rise to a gradual onset of continuous stabbing or aching pain, often during the night or in the early morning, referred to the umbilicus at first and later to the right iliac fossa. Vomiting sets in soon and is not, as a rule, severe, and there may be a slight rise of temperature up to about 100.° The tongue is dirty, constipation is usually present, and the pulse rises steadily from the first and remains full and bounding. There is tenderness at McBurney's point, rigidity of the right rectus and dulness in the right iliac fossa, all of which signs, in a bad case, gradually spread to the other side. The liver dulness in the chest is usually found to be raised about one rib's breadth, and there is often a history of previous attacks. At first there is no swelling to be felt, but a swelling gradually appears in two or three days.

An inflamed appendix lying in the pelvis may give rise to obscure symptoms ; pain, tenderness and rigidity may be as marked on the left as on the right side, but in this case there will be pain on micturition, frequency and tenderness on the right side of the rectum, to be felt per rectum. The resemblance to acute salpingitis (see p. 725) may be great.

(2) **Appendix abscess** comes on after appendicitis has been present for more than three days; the train of symptoms described above is followed by a localisation of the pain, tenderness and rigidity in the right iliac fossa, where a rounded, tender swelling can be felt, which gradually increases in size, while all the symptoms become more marked. *An appendix abscess is always fixed and does not move on respiration.* If the abscess spreads into the pelvis, tenesmus, mucus in the stools and irritation of the bladder may occur. After the formation of the abscess, fever may become higher and the pain more throbbing. The condition often resembles a twisted ovarian cyst, but in a twisted ovarian the palpable swelling is present from the first and may be mobile; in an appendix abscess the swelling only appears after two or three days' illness.

(3) **Acute cholecystitis**: this may come on spontaneously, but usually there is a previous history pointing to gall-stones and biliary colic. There is a rapid onset of severe lancinating pain in the gall-bladder region, going through to the right shoulder, with a high temperature (103° or 104°), rapid pulse, shivering, marked bilious vomiting and great tenderness and rigidity in the right hypochondrium, and all down the right side. A very tender, rounded swelling, moving up and down with respiration, may be felt; there is, as a rule, no jaundice, and the condition is usually seen in stout middle-aged women; moderate distension of the abdomen soon occurs. If in a short time the symptoms increase, collapse occurs and pain, rigidity and tenderness spread all over the abdomen, the pulse rises to 130 or so, and the swollen gall-bladder disappears, it has probably perforated, and peritonitis is setting in.

Differential Diagnosis. (*a*) *From appendicitis:* the temperature is much higher (cholecystitis is the only acute abdominal condition that causes high temperature), the pain, rigidity and tenderness are higher up; the mass, if felt, moves up and down with respiration, and the previous history is often characteristic.

(*b*) *From biliary colic:* here there is sudden, excruciating, grinding pain in the gall-bladder region and right shoulder. Vomiting is not severe, but retching and belching occur; there is no rise of temperature or of pulse rate (the pulse is usually slowed). There is tenderness, but no mass to be felt, whilst the attack passes off after a few hours and may be followed by jaundice. The pain is often relieved by pressure.

(4) **Acute peritonitis,** as a rule, follows upon some other acute abdominal condition after twenty-four hours or so. Pain is intense, stabbing and all over the abdomen, tenderness is acute, vomiting incessant (of a green colour at first, and later dark), and rigidity is marked all over, but later this gives way to great distension. There is absolute constipation and loss of peristaltic sounds on auscultation with a steadily rising pulse rate, the pulse becoming soft and running, whilst the facies Hippocratica, with pale cheeks, anxious expression, and sunken eyes, sets in. The temperature may be a little raised or subnormal (see Chapter XIII., p. 533).

N.B. (*a*) This may resemble obstruction closely, but here the pain is griping and intermittent, the pulse less rapid and running, distension and not rigidity is present, whilst on auscultation, far from silence, there are increased peristaltic efforts going on. Vomiting, if present, is projectile.

(*b*) In post-operative peritonitis following an abdominal operation the picture is less clear, and often incessant vomiting and a steady rise of the pulse rate are the only noticeable features. Pain and rigidity are often absent, but distension will be marked.

(5) **Acute pneumococcal peritonitis** (primary) may resemble the above. It occurs chiefly in small girls, and comes on suddenly without any history pointing to appendicitis as a cause, nor is there any localisation in the right iliac fossa. Diagnosis can be made usually by noting that a marked increase of respiratory rate is present, and though there may be, at first, no signs of pneumonia (which usually sets in later), the alæ nasi may be seen to dilate on inspiration. A vaginal discharge is sometimes seen. The respiration-pulse ratio is increased.

(6) **Acute salpingitis** occurs in young women and gives rise to pain, tenderness and rigidity of gradual onset (two or three days) across the lower part of the abdomen. Vomiting, slight rise of temperature and rising pulse rate are present. The resemblance to appendicitis may be marked (especially a pelvic appendix), but there is less vomiting and constipation, a less dirty tongue, and no elevation of the liver dulness in the chest, while scalding on micturition, a vaginal discharge, and coincidence of the attack with menstruation may be present. The temperature is usually higher, the breath is less foul and headache is often present.

N.B. In the early stages of salpingitis (the first week or so) no mass, swelling, or fixity of the uterus will be felt per vaginam or per rectum, but only tenderness. If a mass is felt, it is a pyosalpinx which is possibly leaking.

(7) **Acute pancreatitis** occurs usually in middle-aged, fat men, often with a previous history pointing to gall-stones. There is a sudden onset of agonising, epigastric pain, with vomiting and severe collapse. The pulse is small, very rapid and running, the temperature is subnormal, and the abdomen distended, soft, and very tender and full in the epigastrium, while tenderness is usually present in the left subcostal angle behind at the outer edge of the erector spinæ. Vomiting becomes persistent and cyanosis of the face may be marked. Glycosuria, leucocytosis and constipation are often present. Because of the epigastric distension and the severity of the vomiting, the pain and collapse, the resemblance to acute obstruction may be great. Loewe's test (see p. 766) and the diastase reaction are often valuable.

(8) **Diverticulitis.** See p. 663.

(B) OBSTRUCTIONS

Acute obstruction in general gives rise to intense pain, usually griping or intermittent, referred to the umbilicus, and of sudden or gradual onset. Soon after the onset of pain, vomiting starts and becomes incessant, accompanied by nausea and expulsive in nature, passing through the stage of green bilious vomit to copious, black, evil-smelling ejections in the later stages. Constipation is absolute, not even flatus being passed, and enemata having no result (though at the commencement the bowel below the obstruction may empty itself); thirst, a dirty tongue, and anxious face are pronounced, and at the commencement there may be a considerable amount of collapse, with a thin, slow pulse and a subnormal temperature. Later on the pulse rises, though not so quickly as in the inflammatory conditions, and a small rise of temperature may occur.

On examination visible peristalsis and distended coils of bowel may be seen and gurgling noises heard, whilst, later, general distension sets in;

increased peristaltic sounds are audible. Note especially whether such distension is in the central or lateral parts of the abdomen or whether it is only local. There is often little tenderness and no rigidity. Various signs pointing to the nature of the obstruction may be present (see p. 678). Later the patient becomes blue, breathless and toxæmic, and the urine is loaded with indican.

N.B. (1) The higher up the bowel the obstruction is, the greater and earlier in onset will be the collapse and vomiting and the less the distension. Small intestine obstruction is more acute than obstruction of the large intestine, and gives rise to central distension; obstruction of the colon causes distension to be more marked in the flanks.

(2) Many cases of obstruction do not come on acutely at once, but are preceded by weeks or months of chronic obstruction, which gradually becomes acute.

(3) Great rapidity of pulse rate suggests that part of the bowel is becoming gangrenous, or has given way above the obstruction.

Differential Diagnosis.

(*a*) *In general peritonitis* the pain is incessant and stabbing, the pulse more rapid, running and thready, whilst tenderness and rigidity are marked. There is no visible peristalsis to be seen, and on auscultation there is a total absence of peristaltic sounds. The vomiting is more effortless and less expulsive, the constipation is less absolute, and enemata may produce results. In peritonitis usually the patient lies absolutely still, while in obstruction he is usually restless and writhes about. The rectum may be found ballooned in either peritonitis or obstruction.

(*b*) In *simple constipation* the symptoms are less marked; visible coils of bowel and visible peristalsis are not present, scybala often may be felt per rectum, and an enema nearly always will give rise to a good action of the bowels. Flatus probably will be passed.

(A) **Strangulated external hernia**: here the essential feature, in addition to the above clinical picture, is the presence of a hernia, which has recently become painful, hard, tender and irreducible, and has lost its impulse. The condition is more often seen in femoral herniæ than in inguinal ones.

N.B. (1) Recent reduction of a hernia should be enquired into, as it is possible that a strangulated hernia has been "reduced en bloc," the strangulation not being relieved, though the hernia has disappeared.

(2) Occasionally only a portion of the lateral wall of the bowel is strangulated (Richter's hernia). In this case, though the general symptoms of collapse are much the same, the vomiting may be less marked and rarely the bowels may continue to act.

(3) The presence of a hernia combined with the symptoms of acute obstruction is not sufficient to diagnose strangulated hernia. The hernia should have become tenser recently, painful, tender and irreducible. Any hernia in a patient who is obstructed from any other cause whatever may fill up with distended bowel, and become larger, but it will not be hard or tender or irreducible.

(B) **Internal strangulation** by bands, apertures, peritoneal fossæ, or obturator hernia often occurs, and involves the small bowel, so that the symptoms are correspondingly severe. Pain and vomiting are very intense and visible peristalsis marked, while there is no external hernia and usually no tumour to be felt (occasionally a distended coil of bowel or a mass of bowel in a peritoneal fossa may be indistinctly felt as a resonant swelling). If distension is present it is usually more marked in the central parts of the abdomen than in the flanks. If the scar of an old operation is present, or there is a history of previous attacks of appendicitis, appendix abscess or peritonitis (tubercular or otherwise), the cause is probably bands or adhesions.

Strangulated obturator hernia, in addition to the above signs and symptoms, may cause pain down the inner side of the thigh, flexion of the hip and an indistinct tender swelling in the groin. It can be felt sometimes per rectum.

(C) **Volvulus** usually occurs in middle-aged men with a history of constipation and may follow a fall or injury. It is usually in the pelvic colon or cæcum.

The symptoms are very severe, the twisted coil becomes rapidly and enormously distended and can be seen or felt as a rounded, local, resonant swelling in the lower part of the abdomen or flank.

(D) **Intussusception** nearly always occurs in fat, flourishing babies, and is often preceded by diarrhœa or an intestinal upset. Intermittent attacks of screaming and pallor are noticed, and vomiting, slight distension, tenesmus and the passage of blood and mucus (often of a prune juice colour) by the bowel, follow, the child rapidly becoming collapsed. A rounded, sausage-shaped swelling may be felt in the right side or upper part of the abdomen, alternately growing hard and soft with peristalsis, while the right iliac fossa may appear abnormally empty. The apex occasionally may be felt per rectum or even protrude from the anus. In late cases the swelling is sometimes felt in the left groin or pelvis.

In older children intussusception usually occurs in the small intestine and then causes no slime or blood in the motions.

N.B. It is often necessary to give an anæsthetic to a small baby to make certain whether the swelling of an intussusception is present or not. Any child that has passed blood and slime in its motions and appears to be in pain must have its abdomen most carefully examined, under an anæsthetic if necessary.

(E) **Gall-stone obstruction** is rare. It occurs in middle-aged women, with a previous history of attacks of biliary colic and cholecystitis. The obstruction is in the small bowel and is very acute, while the impacted gall-stone may be felt as a hard, rounded, movable, tender swelling. This condition is frequently mistaken for another attack of biliary colic because of the previous history.

(F) **Mesenteric thrombosis or embolism** is rare. It gives rise to severe collapse and the usual signs of very acute obstruction, with the exception that often bloody motions are passed. It should not be diagnosed unless murmurs and signs of cardiac vegetations (to cause the embolus), or of arterial disease or of cirrhosis, are present. The affected coil of bowel becomes hard and swollen, and sometimes may be felt as a rounded, tender swelling.

(G) **Obstruction due to growths**: this nearly always occurs in the large bowel and in elderly patients. It is preceded by weeks or months of gradually increasing constipation, accompanied by the symptoms of a growth in the colon (colicky pains, morning diarrhœa, mucus and blood in the fæces and gradually increasing doses of aperients). When acute obstruction supervenes, pain, vomiting and general symptoms may be very little marked, while there is no collapse. Constipation is absolute, and after some days distension may become enormous, involving the flanks as much as, or even more than, the central parts. The tongue often remains remarkably clean and the pulse slow, whilst the growth may be felt either in the abdomen or else per rectum. Secondary nodules may be felt in the liver, at the umbilicus, or in the abdominal wall. In this condition not infrequently sudden acute pain, with collapse, a rapid rise of the pulse rate, and tenderness and rigidity of the abdomen, may supervene. In this case a stercoral ulcer above the growth has perforated into the peritoneum.

(C) PERFORATIONS

These are characterised by extreme suddenness of onset of agonising pain in the region of the viscus perforated, with severe collapse and a previous history pointing to the condition leading to the perforation. Intense rigidity is present, whilst the patient lies absolutely still.

(*a*) **Perforated Gastric and Duodenal Ulcer.** In this case there is nearly always a characteristic history pointing to the presence of either a gastric or duodenal ulcer for months or years before. On perforation, very sudden, intense epigastric pain, with collapse and a pulse, slow, hard and wiry at first, soon becoming rapid, set in. There is little or no vomiting (except possibly that due to the initial shock), and the abdomen is retracted, hard as a board all over, and exquisitely tender. Signs of free gas and free fluid in the abdomen will soon appear. There is no swelling to be felt anywhere. Gradual rise of pulse rate occurs until, in eighteen hours or so, the condition passes into general peritonitis. The patient is pale, collapsed, sweating and lies absolutely still. The liver dulness may disappear. After two or three hours a stage of reaction may set in and the patient temporarily appear much better.

(1) *Duodenal Perforation.* The history here points to duodenal rather than gastric ulceration. It is commonest in men ; pain and rigidity are most marked all down the right side, and the condition, therefore, often resembles appendicitis. The right side of the abdomen becomes dull on percussion.

(2) *Gastric Perforation.* Here the history points to previous gastric ulceration. It usually occurs in young, anæmic women, and pain, tenderness and rigidity are most marked on the left side, which also becomes dull on percussion. In either condition the liver dulness may disappear rapidly.

(*b*) **Perforated Stercoral Ulcer.** Though this may at times occur as a bolt from the blue without any previous warning, it is most unusual for it to happen except when chronic or subacute obstruction are present already, and the symptoms of these possibly may mask those of the perforation. When perforation occurs the signs are similar to those of a perforated gastric ulcer but less dramatic. Sudden pain or increase of pain, with acute tenderness and rigidity, set in. Peritonitis occurs very rapidly, with its syndrome of incessant vomiting, intense pain and rigidity (which may be localised at the site of the perforation), and a rapid, running pulse. Absence of liver dulness and signs of fluid and gas in the peritoneum may be detected in a few hours.

(*c*) **Perforated Meckel's Diverticulum.** This is a rare condition occurring usually in children and closely resembling appendicitis. The pain usually starts centrally and remains so while the localised tenderness at McBurney's point is absent. Retraction of the umbilicus is seldom observed.

(*d*) **Perforation in Diverticulitis.** This may occur in stout constipated middle-aged patients, and not infrequently follows straining at stool. This also closely resembles appendicitis, except that the symptoms are left-sided and there is a definite mass palpable low down on the left side of the abdomen. Occasionally the perforation is retroperitoneal.

(*e*) **Perforated Tuberculous Ulcer** gives rise to symptoms similar to those of other perforations, but the onset is less abrupt, and may be masked by the previous history and signs of tuberculous peritonitis, which will be present. The perforated coil may be so localised by adhesions that, instead of general peritonitis, a local abscess follows the perforation.

(*f*) **Perforated Typhoid Ulcer.** In this condition typhoid has usually been present for two or three weeks, and the question is whether either hæmorrhage or perforation has occurred. In both there is sudden collapse, often with a running pulse and subnormal temperature, but in perforation there will be increase of pain, rigidity and tenderness (see p. 660).

(D) HÆMORRHAGES AND TORSIONS

(*a*) **Ruptured tubal gestation** occurs in women between the ages of sixteen and fifty, as a sudden, severe, hypogastric pain, usually with fainting and vomiting. The patient rapidly becomes pale, blanched, restless and sweating, with a rapid, running pulse, and presents the clinical picture of severe internal hæmorrhage. On examination the abdomen is tender and soft, slightly distended, and may show signs of free fluid, while per vaginam one or other tube may be felt to be enlarged and tender. There will be a history pointing to an early pregnancy (one to three months, though in many cases the patient is quite ignorant of the presence of this), such as the missing of one or two periods, and breast changes, whilst there is usually a small uterine hæmorrhage at the time of onset of the pain (often thought to be the commencement of a period). Previous to the actual rupture the patient often gives a history of irregular colicky pains in the lower abdomen for some weeks or days. The lack of rigidity, the restlessness of the patient and the signs of hæmorrhage will distinguish this from a perforation.

(*b*) **Twisted ovarian cyst** occurs in women often not known to have an ovarian cyst, though if its presence is previously known it will help the diagnosis. Sudden, severe hypogastric pain occurs, without collapse or signs of hæmorrhage. On examination there is usually no rigidity, but there are slight rise of pulse rate and temperature, slight general distension of the abdomen, and a tender, tense, round cystic swelling in the pelvis, very often movable. If the pedicle is long the cyst may lie in the appendix region and closely resemble an appendix abscess, but the swelling appears at the commencement of the illness, while an appendix abscess only appears after a few days. It is also more rounded, of a sharper outline, and may often be movable, whereas an appendix abscess is not movable. Frequently the condition is accompanied by more or less marked diarrhœa, with mucus in the stools.

(*c*) **Ruptured ovarian blood cysts** give rise to symptoms rather suggestive of appendicitis, especially if the right ovary is involved. There is usually little rigidity or sickness, but pain and tenderness are marked, and the pulse rate is more rapid than would be expected from the physical signs and temperature. A little old blood is found in the peritoneum.

OTHER CONDITIONS, RESEMBLING ACUTE ABDOMINAL DISEASES

(1) **Constipation.** This not unnaturally bears a resemblance to acute obstruction, as if severe it may give rise to pain, vomiting, distension and constitutional upset. In constipation, however, flatus is nearly always passed, even though the bowels do not act, while visible peristalsis and coils

of bowel are not seen unless the abdominal walls are very thin. On auscultation there is no increase in the peristaltic sounds. On examination of the rectum it will be found nearly always to be full of hard scybalous masses, while an enema generally will produce a good result.

(2) **Biliary Colic.** See p. 754.

(3) **Renal Colic.** This is localised to the back and loin, on one side, and shoots down to the groin, testicle and thigh. It is associated with vomiting, sweating and shivering, and the patient rolls about in agony. Frequency of micturition and the presence of blood (sometimes only of albumen) in the urine are usually found to occur, while previous attacks are common. Tenderness in the loin should be looked for. Peristaltic sounds are normal on auscultation.

(4) **Pyelitis** causes severe pain, usually on the right side of the abdomen, and may be associated with tenderness, rigidity and vomiting. It can be distinguished, however, by the presence of albumen and pus in the urine, by the tenderness in the loin, and by feeling the tender, enlarged kidney. The temperature is often high, and shivering and rigors are common. The condition is frequently associated with pregnancy.

(5) **Uræmia.** This condition often gives rise to intense vomiting with a subnormal temperature and abdominal distension, while the patient may be profoundly toxic. As in high-up small bowel obstruction anuria may occur, the resemblance may be very marked. In uræmia, however, there are a diminution of peristaltic sounds and no visible peristalsis, while the urine will contain albumen. There probably will be a urinary history pointing to the cause of the uræmia, while other general signs and symptoms of uræmia will be present.

(6) **Dietl's crises** occur in women with a movable kidney; pain, rigidity, vomiting and collapse are present, but the pain is behind and under the ribs, and the firm, tender kidney can be felt as a rounded, movable tumour, which can be pushed up under the ribs (often with relief of the pain). Shivering and fever are present. Peristaltic sounds are normal on auscultation.

(7) **Early pneumonia and diaphragmatic pleurisy,** especially in children, and when involving the lower lobe of the lung, may cause pain, tenderness, and rigidity in the abdomen, before any marked signs appear in the chest. Rigidity, however, disappears momentarily at the end of expiration, and is usually only on one side; the respiration rate is increased to 30 or 40, the temperature is usually higher than that of an acute abdomen (103° or 104° F.), and there are usually no vomiting, collapse, constipation, or deep tenderness. On auscultating the abdomen, the peristaltic sounds are normal.

(8) **Spontaneous pneumothorax,** due to phthisis or emphysema, gives rise to sudden intense pain and collapse. Rigidity is often very marked, and as the pain is referred to the epigastrium, and the patient previously may have had indigestion due to phthisis, a perforated gastric ulcer may be imitated closely. An examination of the chest and the displacement of the heart should avoid this mistake, however.

(9) **Gastric crises of tabes** cause pain and intense and persistent vomiting, but the pulse is unaffected, and there is a characteristic history of regular recurrence of similar attacks. The signs of tabes are present and cannot be missed if they are looked for. Too much reliance, however, must not be placed on the knee jerks, as in tabes of the upper dorsal roots they may be unaffected, while in this case gastric crises are particularly liable to occur.

(10) **Henoch's purpura** occurs in children and gives rise to pain, vomiting

and passage of blood per rectum. Submucous hæmorrhages in the bowel may give rise to palpable sausage-like tumours and resemble intussusception, but the blood per rectum is bright red, and there is no slime or collapse. Purpuric spots are nearly always present. Occasionally these purpuric spots have been noticed upon children and been thought to be old flea bites!

(11) **Thoracic Injuries.** In all varieties of thoracic injuries, there may be abdominal pain, rigidity, tenderness, vomiting and collapse. Such injuries especially may be accompanied by abdominal injuries, and should any serious doubt exist the abdomen had better be opened at once.

(12) **Coronary thrombosis** causes epigastric pain, vomiting, rapid pulse and collapse, and thus may superficially resemble an acute abdominal condition. The general appearance and condition of the patient and the absence of rigidity should prevent a mistake being made.

(13) **Atheroma of the abdominal aorta** may cause colicky pain, distension and sickness and resemble a mild degree of obstruction (*Angina Abdominalis*).

(14) **Abdominal influenza** (so called) often resembles the acute abdomen, especially a mild appendicitis. Here, however, there are usually headache, backache, sore throat, and often a high temperature. Rigidity is generally absent, pain is colicky, griping and diffused, and there is no local tenderness over the appendix, but a diffuse tenderness all over the abdomen. If the abdomen is opened by mistake in this condition the whole bowel (and the appendix) will be found red or pink, and a little watery fluid will be present.

(15) **Typhoid** at its commencement often causes pain and tenderness in the right iliac fossa. There is no rigidity, and the headache, high fever and diffuse abdominal signs should prevent a mistake being made. Many appendices have nevertheless been removed by mistake at the commencement of typhoid.

(16) **Diabetes.** Severe cases of diabetes with marked ketosis and acidosis have been described in which intense abdominal pain accompanied by vomiting has occurred. Tenderness, rigidity and high leucocytosis may be present. Adequate insulin treatment usually relieves the condition. These cases are, however, very rare.

N.B. In every case of suspected acute abdominal disease, always *examine the chest, the gums, the urine, and the nervous system.*

CHAPTER XVIII

THE LIVER, GALL-BLADDER, AND BILE-DUCTS

DISEASES OF THE PANCREAS AND SPLEEN

Surgical Anatomy. The liver, by far the largest of the solid viscera, weighs about 40 ounces, is situated beneath the dome of the diaphragm, and curves round the prominence of the vertebral bodies as they project forwards. The lateral and anterior aspects are for the most part protected by the ribs, lying external to the arch of the diaphragm; for a small area, however, in the midline below the xiphisternum, the liver lies in direct contact with the anterior abdominal wall. The liver is roughly pyramidal in shape, the main mass being situated to the right of the midline, while the apex lies to the left, and is sufficiently pliable to take the impress of the organs in contact with it. The *upper, anterior and right surfaces* and the upper portion of the posterior surface are in contact with the diaphragm, except between the costal margins anteriorly and over the vertebral bodies, where the aorta lies behind the Spigelian Lobe. The majority of these surfaces are covered by the peritoneum of the greater sac, but the Lobus Spigelii is in contact with the lesser sac of the peritoneum, and between the attachment of the two sacs (the reflection of the coronary ligaments) there is situate the roughly quadrilateral " bare area," where the upper and back part of the liver is in direct contact with the superjacent diaphragm.

The *postero-inferior surface*, pointing downwards and backwards, is divided from before backwards by the longitudinal fissure into a larger right and smaller left lobe, and from the left side of this fissure the transverse or portal fissure passes laterally between the left lobe and the Lobus Spigelii. To the lips of this portal fissure are attached the reflections of the lesser and greater sacs respectively, which, passing to the lesser curvature of the stomach, constitute the posterior and anterior layers of the lesser omentum. The surface is in contact mainly with the stomach to the left of the longitudinal fissure; to the right of this lie the pylorus, duodenum and gall-bladder, and further out on the right lobe may be seen the impress of the right kidney and suprarenal body, and the hepatic flexure of the colon. Traversing the fissure between the Lobus Spigelii and the right lobe is the inferior vena cava, into which the hepatic veins open directly; between the layers of the lesser omentum the portal vein, hepatic artery and lymphatics enter the liver, while the bile-duct leaves it. The prominence of the left lobe lying anterior to the transverse fissure is called the Tuber Omentale, and lies against the lesser omentum, through which it is in contact with the Tuber Omentale on the neck of the pancreas.

For general purposes the outline of the liver can be indicated on the surface of the body by a line joining the apex beat of the heart to the right nipple, this line being concave downwards to the midline, and then convex upwards with the highest point at the right nipple to the mid-axillary line, whence it is continued down to the right costal margin. The line is then drawn along the costal margin to the point opposite the ninth costal cartilage where the transpyloric line cuts the costal margin, and thence is continued across the anterior abdominal wall to the seventh costal cartilage on the left side, and so on to the apex beat.

The gall-bladder fundus is situated beneath the ninth right costal cartilage, but is not normally palpable.

In a thin subject the anterior margin of the liver can be palpated, moving down beneath the ribs in deep inspiration, but unless the organ is enlarged this is not possible in moderately fat, let alone obese, patients.

Riedel's Lobe is the name given to a projection sometimes seen coming from the right lobe and hanging below the costal margin. From its position it is liable to be mistaken for an enlarged gall-bladder, but has a sharp lower margin.

Blood Supply. The arterial supply is derived from the hepatic artery, one of the three branches of the cœliac axis artery. This vessel reaches the liver by passing downwards and to the right across the vena cava, and behind the lesser sac of the peritoneum; it then crosses beneath this, passing above the first part of the duodenum, and here gives off its large gastroduodenal branch, which runs down behind the pylorus. The hepatic artery, much diminished in size, then turns upwards between the layers of the lesser omentum, lying to the left of the common bile-duct and anterior to the portal vein, and enters the portal fissure, where it divides into its terminal branches, the right and left hepatic vessels. Thus it will be realised that the hepatic artery forms firstly a posterior, then an inferior, and lastly an anterior, relation to the foramen of Winslow. The *cystic artery*, which supplies the gall-bladder, is normally a branch of the right hepatic, and accompanies the cystic duct to the neck, and later supplies the fundus of the gall-bladder, lying behind and to the left of that viscus. The vessel, however, may arise from the left hepatic, main hepatic or even rarely, from the gastroduodenal artery.

The *portal vein*, formed by the junction behind the neck of the pancreas of the superior mesenteric and splenic veins, with the latter of which the inferior mesenteric vein has already joined, runs up behind the hepatic artery and common bile-duct in the right free edge of the lesser omentum. In the portal fissure it splits into two branches, conveying the blood from the whole of the intestinal tract into the great capillary plexus of the liver. It must be remembered that there are no valves in the veins of the portal circulation, so that, should any obstruction exist in the liver, the congestion will be reflected to the extremities of the circulation (cf. Hæmorrhoids, Chapter XIX., p. 790), and this also will explain the hæmatemesis which occurs in hepatic cirrhosis (p. 741).

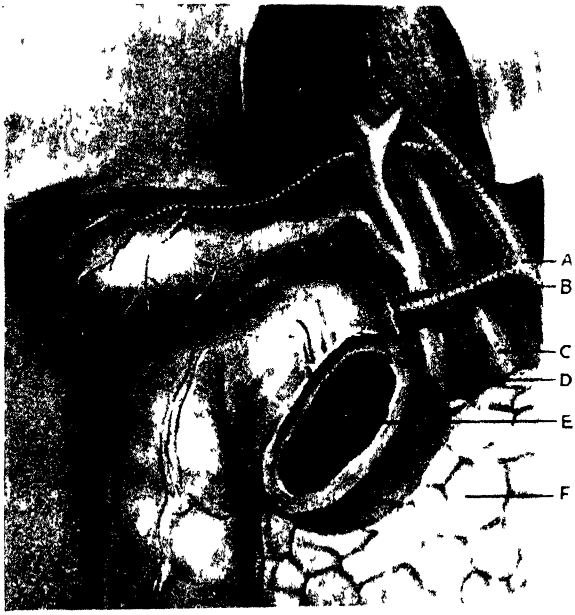


FIG 258. Anatomy of the gall-bladder, etc. A wedge of the liver is removed to show the transverse fissure. A. Hepatic artery with cystic artery higher up, running across the gall-bladder. B. Gastro-duodenal artery. C. Portal vein. D. Common bile-duct. E. Duodenum. F. Pancreas.

The *lymphatics* from the intestine mainly pass up with the portal vein to the transverse fissure, and there are numerous lymph nodes along the portal vein and between the lips of the fissure; enlargement of these from any cause is liable to result in jaundice from pressure on the hepatic ducts. The majority of the lymphatics do not enter the liver, but unite into one or two large trunks, are joined by those from the lesser curvature of the stomach, and pass down behind the lesser sac to the receptaculum chyli, which they enter at the right upper angle. The lymph thus direct to the thoracic duct, and so up into the left innominate vein, so that, particularly in lesions of the lesser curvature of the stomach, enlarged lymph nodes may be detected above the clavicle on the left side of the neck. Some portion of the lymph, however, does traverse the liver, these vessels joining the thoracic duct in the posterior mediastinum.

The nerve supply of both liver and gall-bladder is derived from the last three dorsal, upper lumbar, and probably right phrenic nerves through the semilunar ganglia, whence also sympathetic fibres are derived. It is referred pain along the accessory branches of the phrenic, from the second dorsal, which explains the right scapular pain in biliary colic.

The **Gall-Bladder** is an ovoid sac usually 2 or 3 inches long, attached to the under surface of the right lobe of the liver, beneath the sharp free edge of which the rounded fundus of the sac projects under the ninth right costal cartilage, *i.e.*, at the point where the transpyloric plane of Addison cuts the right costal margin. Except for the area—about one-quarter of its surface—where the upper part of the gall-bladder is in contact with the liver and cystic vessels, it is invested with peritoneum. The wall contains elastic tissue and unstriped muscle, and is capable of contraction. Normally the organ holds about 1 ounce, but it may be much distended, and is supposed to act as a reservoir for bile between meals, though, as the liver secretes about an ounce of bile an hour, this is doubtful. Certainly the common duct dilates following excision of the gall-bladder, an operation attended with no untoward results. The long axis of the gall-bladder is backwards, upwards, and to the left, and the narrow "neck" lies in the right end of the portal fissure, where it is continuous with the tortuous spiral *cystic duct*. The cystic duct lies between the layers of the lesser omentum, at the extreme right edge, and is somewhat over 1 inch in length if straightened out, but normally, owing to its tortuous course, is only about ½ inch long. The duct lies between the expanded ampulla at the neck of the gall-bladder and the *hepatic duct*, which it joins at an acute angle. The interior of the cystic duct is occupied by a spiral valve of mucous membrane, which so narrows the lumen that it is difficult to pass a probe along it, though if straightened the duct will easily accommodate a No. 5 rubber catheter. The gall-bladder seems to act as a reservoir and is undoubtedly capable of concentrating the bile to a great extent, while its lining epithelium secretes cholesterin, having separated this apparently from the blood.

Cholecystography. Recently, by the administration of tetraiodophenolthalein, a drug for which the biliary epithelium has a selective action, it has been possible to obtain X-ray photographs of the gall-bladder. For details of the administration of the drug, and for the X-ray technique, see Vol. I., Ch. XXIII. The vast majority of cholecystograms give an accurate picture of gall-bladder function, and show clearly the presence of stones, but it must be realised that in a proportion of cases a normal cholecystogram will be shown where chronic cholecystitis and gall-stones (formed from cholesterol) are present in an advanced degree.

The **Common Bile-duct** is formed by the junction of the right and left hepatic ducts with the cystic duct, which, as already noted, lies in contact with the hepatic duct, which it joins at an acute angle. The common duct is about the circumference of the little finger, and may be much larger. The duct passes down in the right free edge of the lesser omentum, having the hepatic artery on its left and the portal vein behind it, and can be readily explored by the finger in the foramen of Winslow. The bile-duct passes behind the first and second parts of the duodenum, lying to the inner side of the latter and overlapped by lobules of the head of the pancreas. It joins with the pancreatic duct (duct of Wirsung), enters the second part of the duodenum, and opens into the bowel through the papilla on the postero-internal aspect having the entrance protected by a sphincter (Oddie), which relaxes when acid stomach contents enter the duodenum, and permits bile, expelled from the contracting gall-bladder, to enter the bowel. Where the ducts join there is a dilatation, known as the *ampulla of Vater*, and it is here that gall-stones often lodge, giving rise to jaundice and pancreatic infection. The bile-duct is usually accompanied by the two stems of the superior pancreatico-duodenal artery, which run in front of and behind it, while the anastomosis with the inferior vessel, which is free, occurs around the ampulla of Vater. The ducts are lined with columnar-celled epithelium and have many tubular glands which secrete a mucinous fluid, capable in some cases of obstruction of filling the gall-bladder or ducts and constituting "White Bile."

The **Foramen of Winslow**, which is a slit-like communication between the greater and lesser peritoneal sacs, is reached by passing the finger along the right side of the fundus and body of the gall-bladder, and so beneath its neck. The foramen may be obliterated by adhesions in old-standing inflammation around the neck of the gall-bladder. With the tip of the index finger lying in the foramen of Winslow, its boundaries, which are very important, can be easily defined. Above lies the Lobus Spigelii of the liver and the neck of the gall-bladder, at the extreme right edge of the transverse (portal) fissure; behind lies the inferior vena cava, across which runs the hepatic artery, and over which lies the peritoneum of the lesser sac. Below, the finger rests on the first part of the duodenum, crossed from behind forwards by the hepatic artery, which is here giving off its gastroduodenal branch; while in front lies the right free edge of the lesser omentum, containing the portal vein and common bile-duct, lying anteriorly and somewhat to the right, with the hepatic artery to its left side.

INJURIES TO THE LIVER AND GALL-BLADDER

Injuries to the liver have already been discussed (Chapter XIII., p. 518), and, as has been pointed out, usually result from penetrating wounds (Fig. 187) or crushes, though protection is afforded by the ribs. Owing to the vascular condition of the organ the chief sign and danger is hæmorrhage, though other viscera are often damaged, and there is considerable shock.

In penetrating wounds the hæmorrhage is external, but in crushes internal hæmorrhage (p. 517) will occur, and may escape diagnosis; in either variety it is free, and often rapidly fatal.

The condition calls for immediate laparotomy, and tears or wounds should be sutured or plugged. In slight cases spontaneous healing will occur, and in such there may be jaundice, which usually comes on a few days after the accident. Occasionally post-mortem examination after death from other causes may reveal that there has been a previous extensive laceration of the liver which has healed spontaneously.

Rarely a *subcapsular hæmorrhage* occurs following a blow in the epigastrium, when the edge of the liver may become palpable or increased liver dulness be noted, while very occasionally blood flows into the falciform ligament, which can be palpated through the abdominal wall. There is pain in the area. The condition is generally met with in children and calls for no further treatment than rest in bed under observation till the blood clot has been absorbed, usually a period of from fourteen to twenty-one days.

Injuries to the gall-bladder and bile ducts are uncommon, apart from tearing of the bile capillaries in rupture of the liver, and usually result from perforating wounds, when the escape of bile, mingled with blood from wounds beneath the right costal margin, should indicate the nature of the damage. Rarely a distended gall-bladder may be ruptured by a blow on the abdomen, and still more rarely the hepatic ducts may be torn in crushing accidents of a twisting nature. In either case there is considerable shock, which soon passes, and as the bile in such cases is usually infected, peritonitis comes on rapidly and is acute, for the invasion by the micro-organisms is aided by the peritoneal digestion from the bile. In those cases where the hepatic ducts are torn there is usually rupture of the liver, and sometimes of the duodenum (Chapter XV., p. 636), the signs of which will overshadow the biliary damage.

Occasionally some weeks after an injury a large bile-containing cyst may form in the epigastric region, following rupture of the bile-ducts, and can be detected on palpation as a rounded mass, which may be mistaken for a peri-gastric abscess (see p. 624).

In all such cases exploratory laparotomy is urgently needed; a ruptured gall-bladder needs excision, and torn ducts must be sutured with fine catgut, or should this not be feasible the ends must be crushed and ligatured. If this has to be the procedure with the common bile-duct, a suture of the gall-bladder to the stomach or duodenum is then performed and a drain is left down to the area, as some leakage of bile is likely to occur.

Bile and blood clot should be sponged out, and the peritoneal cavity closed around the drain, which should be removed in forty-eight hours.

The **portal vein** is occasionally wounded in perforating wounds, and death usually occurs in a few hours from hæmorrhage. Should the condition be diagnosed, operation should be undertaken and the vein sutured, or, if this is impracticable, ligatured. Recovery has ensued after ligature of the main portal vein, though this is succeeded by a period of marked wasting, and the result in many cases is not so successful.

DISEASES OF THE LIVER

Acute infection of the liver is not common and is usually blood-borne secondarily to an acute inflammation in the intestine, most often appendicitis, or to acute cholecystitis. In either case the liver infection is in the nature of a pyæmia, and multiple acute abscesses occur in the liver substance; the infection may be primarily blood-borne (suppurative pylephlebitis), or in the bile-ducts (suppurative cholangitis), when the infection is probably via the lymphatics. In either case there is usually a rapidly fatal termination, and even in apparently mild cases, after removal of the primary cause, the prognosis must be very guarded.

(*a*) **Acute suppurative pylephlebitis** is, as already stated, usually secondary to operations for acute appendicitis, but may follow diverticulitis and other acute infections of the intestinal tract; it is also seen as a sequel to infection of the umbilicus in infants, and sometimes results from suppurating hæmorrhoids, especially if these are operated on in an inflamed state (Chapter XIX., p. 790), and also occasionally in generalised pyæmia, the infection then being brought by the hepatic artery and not the portal vein. The infection is almost always mixed, Bacillus coli and staphylococci being the micro-organisms most commonly met with. The whole liver is enlarged and congested, and multiple abscesses, varying in size from a pea to a large potato, are found throughout its substance, while if the case has gone on for some weeks there is usually considerable thickening of the liver capsule (perihepatitis).

Clinically the onset is usually insidious in a patient often apparently recovering from an acute intestinal calamity. It will be found that progress is arrested, and the patient loses ground and wastes, night sweats appear, and often some pain and tenderness in the neighbourhood of the liver. Diffuse griping abdominal pains are felt, and rigors then occur, sometimes at rare, and at others at frequent, intervals, while the liver becomes markedly tender and its edge palpable below the costal margin; more rarely the upper limit of dulness may be found to be raised. Occasionally a rigor is the first indication. Jaundice is uncommon, but may occur to a slight and usually varying degree in the later stages when many abscesses are present.

The abdomen is usually distended, and vomiting and drowsiness present.

The diagnosis may be by no means easy in the early stages, before the rigors manifest extensive abscess formation, and both *subphrenic abscess* and *peritonitis* may be suspected. In the former case an X-ray film shows the diaphragm to be raised, and the liver edge, if palpable, is not markedly tender, while rigors are very uncommon. Peritonitis, if acute, is not likely to cause confusion, but the subacute form, not actually progressing to suppuration (subphrenic and other abscesses), where adhesions and matted bowel exist, may give rise to serious difficulty in diagnosis, though the abdomen has a lumpy, doughy feel that is characteristic, and the infection is seldom confined to the neighbourhood of the liver, while rigors are not at all likely to be met with. *Chronic cholecystitis* with exacerbations (p. 747) may cause difficulty, and also *suppurative cholangitis*, which is often an associated condition.

The *treatment* is purely symptomatic; though a few successes have been reported as a result of ligaturing the left colic vein or the superior mesenteric vein just above the clot and below the transverse mesocolon, in the early stages, as a rule, surgery is contra-indicated in the vast majority of cases, and, indeed, is only advisable where in subacute infections one large abscess is paramount, in which case it may be drained by laparotomy. If seen in the early stages any primary focus should be eradicated in the hope of removing any further source of infection.

(*b*) **Suppurative cholangitis,** which often occurs with the foregoing condition, is probably due to lymphatic infection; it is seen more commonly after cholecystitis, but may occur as a direct bile infection in connection with gallstones, especially if these obstruct the bile-ducts (p. 758). There is great distension of the ducts, which are thickened and filled with a yellowish-green cheesy mass.

The *signs and prognosis* closely resemble those seen in suppurative pylephlebitis, save that they are more rapid in onset and termination, and jaundice is an early and persistent sign, though seldom very marked in amount; it can be detected first in the blood serum and urine, and then in the conjunctiva before being seen in the skin.

The *diagnosis* is also as for pylephlebitis, but here one has also to guard against more chronic jaundice from such conditions as amœbic abscess, cirrhosis, or carcinoma which has pre-existed the onset of some acute disease, being mistaken for the jaundice associated with the onset of suppurative cholangitis.

Treatment, as in pylephlebitis, is usually of little avail to prevent a fatal termination of the condition, though drainage of the bile-ducts may cause amelioration of the condition.

Chronic infections of the liver are seen more frequently, and either of the foregoing conditions may occur, though rarely in a chronic form. More often the infection, instead of being due to pyogenic organisms when the abscesses are multiple, is due to infection from the bowel in cases of chronic dysentery by the *entamœba hystolitica,* and then a solitary abscess results, or else perihepatitis occurs to a marked extent.

Amœbic perihepatitis and abscess occur in people usually resident in the tropics, but are also seen in South-East Europe, following on amœbic dysentery, especially if the bowel disease is chronic and untreated. The abscess is nearly always solitary, and most often in the posterosuperior region of the right lobe; hence the liver tends to enlarge upwards, and in neglected cases the abscess first causes pressure on the base of the right lung, and later involves the diaphragm and bursts into the bronchi of the adherent right lower lobe, the pus being expectorated.

The abscess may reach an enormous size, containing many pints of pus, which is of a characteristic thick consistence, and brownish-red in colour, much resembling anchovy sauce in appearance.

The abscess wall is ragged, and consists of disintegrated liver tissue and leucocytes, but contains surprisingly little fibrous tissue even in chronic cases. It is in the granulation tissue of this wall that the amœbæ can be found, usually in large numbers, though they seldom can be demonstrated in the pus, which is generally sterile.

Clinically the onset is usually insidious, and the signs of abdominal disease frequently very slight. The patient often complains of steady and progressive loss of weight, and may be markedly wasted, but in early cases this is not so. There is often persistent pain deep to the right scapula of a dull aching character, and the complexion takes on a characteristic earthy hue. There is usually a daily rise of temperature to about 99°–100° F., and frequently sweats occur. Diarrhœa may be present, but is not usually pronounced, though a careful investigation will elicit usually a history of attacks of diarrhœa, when the stools are of the typical offensive grey purulent type met with in amœbic dysentery. Such attacks often can be brought on by a meal of raisins or grapes, and the amœba hystolitica isolated from the stools. This clinches the diagnosis. " Phrenic pain " may be felt at the tip of the shoulder, and this is especially common when the abscess is threatening to break through the diaphragm into the thorax.

A blood count will show marked eosinophilia and leucocytosis. The liver is seldom palpable, unless much perihepatitis is also present, but there is often tenderness under the costal margin, and also in the right subcostal angle behind. The liver dulness can be found to be raised if an abscess of any size be present, and there are often dulness, impaired air entry and crepitations over the lower lobe of the right lung.

If untreated, the condition of the patient steadily deteriorates, as the abscess increases in size. The abscess may burst into the peritoneal cavity, when death results in a few days from peritonitis, but, as already stated, it usually points upwards through the diaphragm and, bursting into the already adherent right lung, causes free expectoration of " anchovy sauce " pus. This may be followed by spontaneous cure, but more often secondary infection ensues, with pyopneumothorax and consequent death. Should the lung not be adherent, a right empyema will follow rupture of the abscess through the diaphragm, or more rarely pyopericardium.

Diagnosis is by no means easy, unless the entamœba hystolitica can be isolated from the stools, or the patient is known to have had amœbic dysentery.

Many of these cases are diagnosed as *pulmonary tuberculosis*, but the absence of signs at the apices, the leucocytosis and eosinophilia, and the earthy, sallow complexion should prevent mistakes arising in a patient who has returned from abroad.

From *amœbic perihepatitis* there is no need to attempt diagnosis, as both conditions are usually coexistent and their treatment is the same. The aspirating needle has been advocated, but should never be used, as infection of the pleura and abdomen may follow leakage along the track of the needle, and the thick pus is often not withdrawable when present.

Hydatid cyst (especially if suppurating) and *subphrenic abscess* also may give rise to errors in diagnosis.

Treatment consists in the administration of emetine, either by subcutaneous injections of emetine hydrochloride, gr. i., daily, or by the oral administration of ampoules of bismuth emetine iodide, which is equally efficacious, but tends to produce nausea and vomiting. Thorough dosage with this drug will cure hepatitis, and abscesses of great size will absorb and disappear.

Resource to surgery, therefore, is seldom necessary, but very large abscesses will be cured more rapidly if incised and sutured after evacuation of pus, and washing out of the cavity with emetine solution and quinine. Should the abscess be opened under a misapprehension as to its nature, the pus may be evacuated, the cavity washed out, and the liver sutured. Drainage must be employed down to the liver for a few days, and energetic treatment with emetine undertaken. Probably the best route of approach is from the side, with removal of the ninth or tenth ribs in the axillary line, provided it is certain that the pleural cavity is already obliterated, when the diaphragm is incised and the abscess opened ; in all other cases a transperitoneal operation should be advocated.

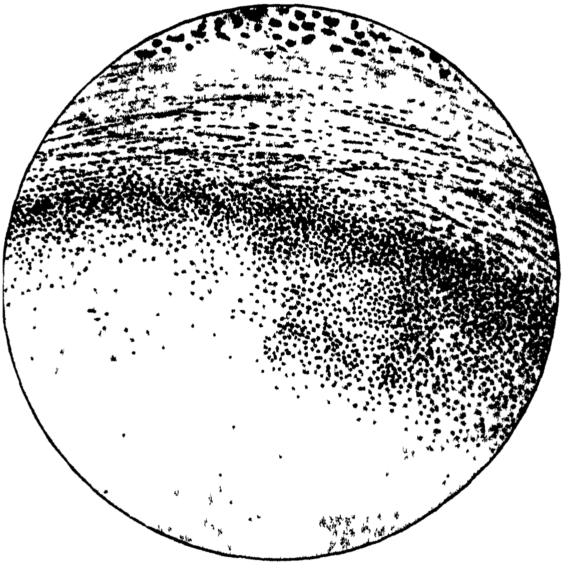


FIG. 259. Gumma of liver (edge of caseous area). × 45.

Tuberculous infection of the liver occurs as :—

(1) A *perihepatitis* in tuberculous peritonitis, when the peritoneum is much thickened, and studded with greyish translucent tubercles, which may break down and give rise to caseous foci on the surface of the liver.

(2) *Miliary tubercles* may be disseminated throughout the liver in miliary tuberculosis.

(3) *Tuberculous abscess* may occur in the liver, usually in the region of the portal fissure, secondary to bowel infection, or several abscesses may occur on the surface in tuberculous perihepatitis.

None of these conditions calls for any special description, for they are usually masked by other foci of the disease. Should a localised abscess be discovered during a laparotomy for tuberculous peritonitis, the pus should be evacuated, the cavity swabbed out with strong carbolic or hydrogen peroxide and obliterated with catgut sutures. Care, of course, must be taken to pack off the peritoneal cavity with gauze swabs before opening the abscess.

Syphilis of the Liver. In the tertiary stages of syphilis, both congenital and acquired, gummatous manifestations are frequently met with in the liver, and, as in all such lesions, may be either localised or generalised.

Localised gummata may be single or multiple, more often the latter, and are usually met with in adults who have acquired syphilis. The granulomatous lesions may occur anywhere in the liver, and if near the surface form rounded projections, the peritoneum over which is thickened and fibrosed. Later these areas soften, and usually absorb, calcification often occurring among the fibrous scar tissue which is always present and causes dimpling and retraction of the liver surface.

Clinically jaundice is uncommon, but the liver often can be felt, as the result of perihepatitis and some enlargement, and in these subjects the surface can be felt to be studded with rounded and markedly tender nodules. Ascites is uncommon and never great in amount. Pain and tenderness are marked. The Wassermann reaction is always strongly positive.

The diagnosis has to be made from secondary malignant nodules of carcinoma, where jaundice and ascites are usual, umbilication often can be felt and no tenderness is present, and cirrhosis of the liver, where ascites is present and the liver seldom palpable, or, if so, it feels smooth.

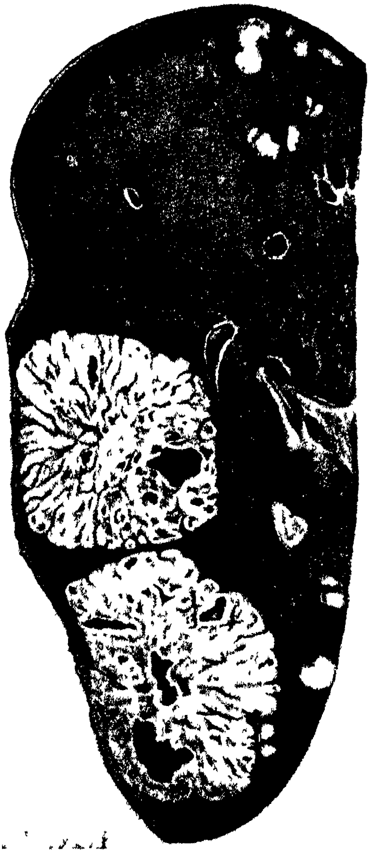


FIG. 260. Actinomycosis of the liver.

Rarely a hæmorrhage may occur into a breaking-down gumma, when an acute abdominal crisis is closely simulated, the condition being probably diagnosed as acute pancreatitis or cholecystitis, and the true state of affairs not realised till operation. A similar condition is occasionally seen in gummatous lesions around the head of the pancreas.

Diffuse gummatous infiltration is seen in both the congenital and less often in the acquired disease and may affect mainly :—

(1) The peritoneum over the liver, when this becomes enormously thickened and fibrosed—*perihepatitis.*

(2) The liver tissue, when there is an attempt at compensatory hypertrophy with consequent enlargement of the liver, and impairment of function as this fails. This is the type met with in congenital syphilitics, who often succumb to the disease in utero, when the whole liver is packed with spirochætes—*hepatitis.*

(3) The cellular tissue, when *cirrhosis* (of syphilitic origin) will result, while the disease is pericellular ; this is really a late stage of (2), the liver is enlarged, but later becomes shrunken and fibrotic as lobular and lobar changes supervene.

The diagnosis and treatment of these conditions come within the province of the physician, and will not be discussed here, save to mention that a generalised hepatic enlargement, especially if associated with slight jaundice and cirrhosis, always should point to the necessity for a Wassermann reaction, more especially if the condition occurs in a child or young adult.

Actinomycosis. This occurs not infrequently in the liver, either secondary to disease in the intestinal tract, when the lesions are often multiple, or to pulmonary actinomycosis, when the infection spreads through the diaphragm and commences as a massive infiltration in the upper and back part of the liver, in the " bare area."

In either case the lesions consist of multilocular abscesses, containing pus full of the characteristic yellowish granules, and much resembling a sponge in appearance (see Vol. I., Ch. VI.).

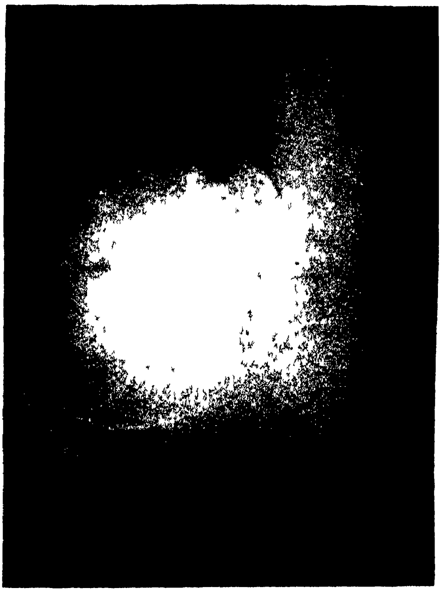


Fig. 261. Calcified hydatid cyst in the liver.

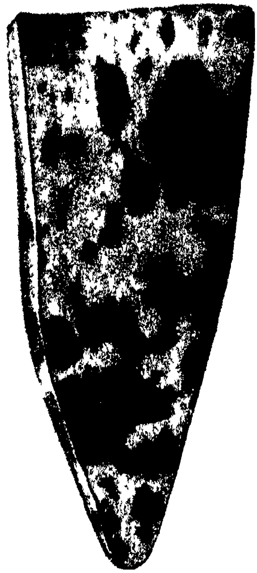


Fig. 262 Hæmangioma of liver.

Clinically usually the liver may be enlarged and palpable, and other foci of the disease may be detected.

Treatment consists in general treatment with iodides or vaccines, as suggested in Vol. I., Ch. VI. Local treatment is seldom practicable, and the disease is always fatal in a few months.

Cirrhosis of the Liver. This is a condition due to a variety of causes in which there is an enormous increase in the fibrous tissue with consequent strangulation of liver cells and constriction of vessels. The disease is of no interest to the surgeon per se, and is dealt with in detail in medical text-books.

The *ascites* consequent on the cirrhosis may call for surgical interference for its relief, either by tapping or some operation of the Talma-Morrison type (Chapter XIII., p. 556). Various operative procedures for ascites are also described on p. 556.

The relationship of hepatic cirrhosis to piles will be dealt with in Chapter XIX.

Hydatid cyst occurs not infrequently in the liver, as might be expected when it is remembered that the Tænia echinococcus ovæ are ingested from the alimentary canal. It is, of course, more common in natives of those countries, such as Iceland or Australia, where hydatid disease is frequent (Vol. I., Ch. VI.). The cyst is usually solitary, and most often met with in the right lobe of the liver, though it may occur in any part of the organ, even projecting as a rounded pedunculated mass from the lower surface. There is a thickened ectocyst, which may calcify not infrequently in chronic cases (Fig. 261), and a thin-walled endocyst from the inner wall of which scolices and daughter cysts bud off and lie free among the clear fluid; sometimes infection of the cyst contents sets in, and, if the inflammation subsides, absorption of the fluid occurs and a pultaceous putty-like mass is left occupying the cavity of the ectocyst.

Rarely more than one cyst may exist, in which case great hepatic enlargement is present, and occasionally exogenous multiplication will give rise to hundreds of cysts, varying in size from a marble to a golf ball, which occupy the entire liver. In the majority of cases the cyst will lie latent for years, though sometimes it may increase in size and burst into the peritoneal cavity or lung. Should infection occur, all the signs of an hepatic abscess will manifest themselves.

Clinically there may be a history of previous trouble from known hydatid infection, or of acknowledged risk of such infection. There is gradual enlargement of the liver, pain in the right scapular region, and some biliousness and anæmia. Attacks of urticaria may occur, and synchronise with leakage of fluid from the cyst, while any severe violence which may or does rupture a hydatid cyst will cause severe urticaria, especially over the abdomen. Eosinophilia up to 5 per cent. or over will be present. The Casoni intradermal reaction is positive in the great majority of cases.

If the cyst is in the right lobe the signs will be as described in liver abscess (p. 737), and considerable pressure signs will be detected in the right lower lobe of the lung; indeed only the extreme eosinophilia and the history are likely to establish a diagnosis, unless urticaria has been or is present.

Should the cyst be near the lower margin it may be detected as a rounded prominence, and, if large and sufficiently superficial, "hydatid fremitus" sometimes may be elicited in this; X-ray films may be useful in old-standing cases, especially if calcification has occurred in the cyst wall.

If infection occurs there is a hectic temperature and all the signs of a hepatic abscess (p. 737).

As in amœbic abscess, aspiration is to be avoided as dangerous, and cases are on record where it has been attended by death consequent on the cyst contents bursting into and flooding the bronchi; there is always the ever-present danger of leakage of brood capsules into the peritoneum and pleura, with consequent infection.

Diagnosis from the other hepatic enlargements depends on the urticaria, hydatid fremitus, and eosinophilia, only the last of which is constant. The contents of the cyst are characteristic when obtained, consisting of a clear fluid of low specific gravity and containing albumen, in which the scolices can be demonstrated microscopically. The complement-fixation test is usually of value.

Should suppuration have occurred the condition is indistinguishable from an hepatic abscess.

Treatment. This consists either in laparotomy if the cyst is on the lower or anterior liver surface, or approach across the pleural cavity, which, if not obliterated, must be shut off with stitches, when the cyst is deep in the right lobe of the liver. In some cases the cyst may be approached by removing one of the lower ribs, keeping below the pleural cul-de-sac, and then incising the diaphragm. The firm, whitish cyst wall is exposed, packed off with black or red towels and a few centimetres of fluid withdrawn after puncture with a syringe. Several centimetres of 2 per cent. formalin solution are now injected to kill the daughter cysts and scolices. It is best to open the ectocyst and strip out the endocyst when the daughter cysts and fluid have escaped, care being taken to pack off the peritoneal or pleural cavity first. The cyst cavity may be obliterated in some cases by stripping out the ectocyst, but usually only if this is calcified, and approximating the tissues by a series of catgut stitches; more often this must be attempted without the stripping, as hæmorrhage is severe. The abdomen can then be closed without drainage.

In other cases the edges of the walls of the cavity are sutured to the peritoneum and the cyst marsupialised.

In a few cases, where the cyst projects or is even pedunculated, it may be removed entire, while resection of a portion of the liver may be performed for it.

If suppuration has occurred the abscess needs opening and draining, the infection usually destroys the hydatid, and obliteration of the cavity by granulations is the rule.

Where multiple cysts exist attempts at removal are useless, unless only two or three cysts be present.

NEOPLASMS AND CYSTS OF THE LIVER

(A) *Primary neoplasms* of the liver are very uncommon, but may arise in connection with the hepatic cells, when they are of the epithelial type, or in relation to the capsule and blood vessels, when connective tissue tumours result.

(1) *Cellular neoplasms* may be of a simple nature. There may be an **adenoma,** perhaps the most frequent benign tumour, which presents as a solid reddish encapsuled mass, occurring anywhere in the liver substance, and even projecting beneath the capsule. Such masses may be solitary, when they often attain the size of a golf ball, or multiple, when they are usually smaller. When solitary they may sometimes be enucleated if in a superficial situation.

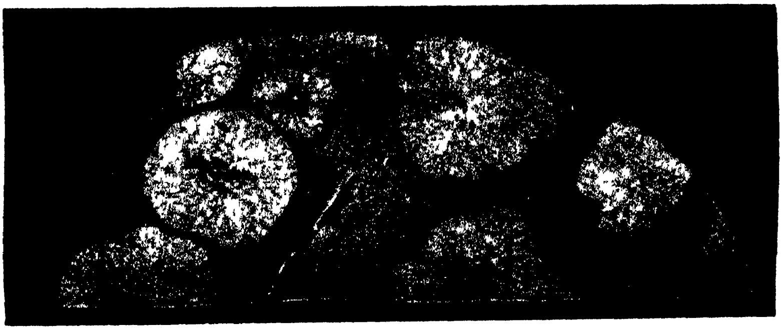


FIG. 263. Secondary carcinomatous deposits in the liver.

Carcinoma is very rare as a primary growth, but is occasionally met with, usually as a central growth or a diffuse infiltration of a spheroidal-celled type, and very soft. The disease is not likely to be recognised even at operation, and usually only in the post-mortem room. It is seen in comparatively young patients.

Clinically the chief sign is a rapid and usually painless enlargement of the liver, with marked loss of weight, asthenia, and perhaps slight jaundice. No diagnosis is likely till the condition is beyond surgical aid, though occasionally, as when the disease starts in Riedel's lobe, the carcinoma may be diagnosed early and excised together with the affected lobe. Recurrence, however, is frequent.

Hypernephroma occasionally occurs in the posterior part of the right lobe.

(2) *Simple connective tissue neoplasms* are also rare. **Angioma** of a cavernous type is that most commonly met with, and is often diffused throughout a large area of the organ. The tumour is seldom encapsuled and surgical treatment is not called for. *Fibroma* is extremely rare, and usually arises in connection with the capsule.

Sarcoma, usually round or spindle-celled, is most uncommon and differs only from carcinoma, for which it is likely to be mistaken clinically, in its microscopic appearance, and more rapid growth.

In any operation on the liver the diathermy knife will be found most useful, as the tissue is soft and so cuts easily, while hæmorrhage is at once stopped. Nevertheless no operations should be undertaken for the removal of tumours found on laparotomy except by experienced surgeons, and then only if the neoplasm is accessible easily to the surface of the liver. Special needles with blunt points and edges should be used for suturing the liver.

(B) *Secondary neoplasms* are common, and multiple rounded masses of **carcinoma,** secondary to growths elsewhere in the body, are very often met with, especially secondary to intestinal, uterine, and breast neoplasms. There is marked jaundice, ascites, and hepatic enlargement, while the umbilicated carcinomatous nodules when near the surface may be palpable in thin patients. The type of carcinoma, of course, will vary with that of the primary growth, and no surgery is advisable.

Sarcoma also occurs as secondary deposits, especially in melanotic growths, where the liver becomes the seat of coal-black metastases.

Cysts are uncommon apart from *polycystic disease*, which occurs in patients suffering from congenital cystic kidneys (usually children who die young). *Solitary serous cysts* (lymphatic) are rarely met with, which usually project from the lower margin of the liver and may be mistaken for hydatid or omental cysts, as they reach a large size in many cases. Other rare forms of cysts found in the liver are due to breaking down gummata, or teratomata; single congenital cysts occasionally occur, and cyst-adenomata have been described. Big bile-containing cysts due to distension of one of the bile ducts in the liver are also seen.

Displacement of the liver in a downward direction occurs in Glenard's disease, as part of the visceroptosis (Chapter XVI., p. 655); as the liver rotates as well as drops, the lower edge is not easily palpable. Treatment is by means of a suitable belt and tonics; surgery is never to be contemplated.

INFLAMMATION OF THE BILIARY PASSAGES

ACUTE AND CHRONIC CHOLECYSTITIS, CHOLELITHIASIS

Although the liver itself has no connection developmentally or anatomically with the alimentary canal, such is not the case with the bile-duct and its radicles. These are, therefore, very liable to infection from the intestine, as the pressure of the bile is small and the flow intermittent; moreover, as the biliary and pancreatic ducts have a common entrance into the bowel, blockage of this opening or infection of it is very liable to affect both systems. Biliary and pancreatic infections, it thus will be realised, frequently coexist, though one will predominate often so as to mask the presence of the other.

The ætiological bacteria are those usually met with in the intestine, and staphylococci, streptococci, and B. coli predominate largely, as in all such infections. B. typhosus is relatively frequent, and may lie dormant in the gall-bladder for years after an attack of enteric, or be found there in patients who are unaware that they have suffered from the disease. B. welchii is also not uncommon in acute gall-bladder inflammations. It has been found in the centre of gall-stones. The infection in the majority of cases seems to be a direct one via the ampulla of Vater from the duodenum, but in some cases it is apparently lymph-borne, the gall-bladder being affected while the common and hepatic ducts escape infection and the duodenum is apparently healthy. Blood stream infections also occur.

The infection may set up inflammation in the ducts (*cholangitis*), or more often in the gall-bladder (*cholecystitis*), as this is a cul-de-sac and only occasionally empties, and so is obviously more prone to disease. In both conditions the reaction may be acute or chronic in onset, and there may be merely a catarrhal inflammation, or the process may proceed to suppuration in the gall-bladder or ducts, and even gangrene of these may occur.

A common result of such infection, especially if chronic, is the deposit of bile salts, pigments, and cholesterin around a nucleus of mucus and bacteria, so that "stones" are formed in the gall-bladder and bile-ducts (*cholelithiasis*, p. 752).

These infections may occur at any age, but in children, where bile secretion is active, and the digestive tract comparatively healthy, they seldom pass beyond the catarrhal stage, and are also distinctly uncommon. Far otherwise is the case in adult life, especially where a sedentary life and persistent over-indulgence in rich foods have led to a sluggish liver, chronic indigestion, and an obese figure. Such infections become more severe and are frequently seen in city dwellers, more especially occurring in adipose women of about forty to fifty years of age, and especially in multiparæ.

Acute and chronic infections of the gall-bladder and bile-ducts both occur. Although these conditions frequently coexist in both ducts and gall-bladder, especially in the catarrhal or early stage of inflammation, they do not necessarily do so, as the lumen of the cystic duct is narrow, and the mucosa abundant, so that if inflamed and œdematous it easily may obliterate the lumen. The gall-bladder, moreover, often may be shut off from the rest of the biliary passages, either intermittently or permanently, by a gall-stone becoming impacted in the commencement of the cystic duct. In these two contingencies infection may be limited to the gall-bladder, and as this often occurs in actual practice cholecystitis and cholangitis will be discussed separately.

(1) **Catarrhal cholangitis** invariably results from duodenal infection, and is prone to occur in epidemics, often associated with attacks of gastroenteritis (summer diarrhœa). The disease is most often seen in children, but may occur in adults.

The onset is often sudden after, or coinciding with, an attack of gastro-enteritis, but may be gradual, following a period of malaise, anorexia, and a feeling of vague discomfort and fulness in the epigastrium, combined with a distaste for food and pain in the right scapular region. The resulting "**catarrhal jaundice,**" due to escape of the bile into the blood stream, as a result of its being dammed back by the œdema in the bile capillaries, varies much in intensity. There are flatulence, constipation, and pale or clay-coloured stools due to absence of bile in the intestinal tract, while the presence of bile in the urine and skin irritation will depend entirely on the depth of the jaundice. The liver is usually just palpable and slightly tender. As in all biliary infections, there is a tendency to a chilly feeling in the back, shivering, and a daily rise of temperature (*Charcot's intermittent fever*).

The condition is fully dealt with in medical text-books, and beyond reminding the reader that rest in bed, a very light diet, and calomel and saline purges should be resorted to, and that as urotropine given by mouth liberates formalin in the bile, it may be administered with advantage as a biliary antiseptic, no further details of "catarrhal jaundice" will be discussed. Surgery has no place in the treatment of this condition.

(2) **Suppurative cholangitis** almost always supervenes on infection from the duodenum following obstruction in the common bile-duct, from impaction of a gall-stone, or carcinoma. It therefore occurs in the vast majority of cases in patients already deeply jaundiced. In a few cases it may occur as a pyæmic infection of the liver from disease elsewhere, when there is comparatively little jaundice, as the infection is in the bile capillaries. This condition, which is nearly always fatal, has been discussed on p. 737.

When supervening on obstruction in the common duct, there is often an onset of rigors, and a marked rise of temperature, which may reach 103° F., and is of an intermittent type. The patient is gravely ill, and such signs supervening on an obstructive jaundice should lead to immediate laparotomy with a view to removal of the obstruction if possible, and drainage of the common duct, which together with the hepatic radicles will be found distended with pus and much inflamed.

If left untreated death usually occurs, but sometimes the gall-stone will ulcerate through the duct wall, when, as adhesions from omentum have usually already formed around, a localised abscess generally results. Acute pancreatitis (p. 764) and pylephlebitis are common and often rapidly fatal complications.

(3) **Chronic cholangitis** is the result of infection from the bowel, and may follow on a definite attack of "catarrhal jaundice," but more often is of insidious onset. The condition is met with most often in adults who lead a sedentary life, and usually complain of chronic biliousness, or feeling "livery" and bad tempered. Gall-stones are usually associated with this chronic inflammation in the ducts, and not only the common but the hepatic and even the smaller ducts may be found packed with calculi, which are often deeply pigmented and faceted. Biliary colic, the result of irritation and spasm of the muscular wall, due to the attempted passage of the stones, is frequent and often severe, while jaundice is an almost constant symptom. The jaundice may be very deep, but usually varies in intensity from time to time. Suppuration in the ducts, the result of infection from the duodenum, is a common complication.

Similar conditions usually coexist in the gall-bladder, but owing to obliteration of the cystic duct, this is usually shut off from the rest of the biliary tract, though it often contains stones and may be either distended or shrunken around these.

It thus follows that in all cases where the gall-bladder is found chronically inflamed the bile-ducts must be explored carefully for signs of infection or calculi. Most surgeons rely on an external digital examination, but some prefer to open, explore and drain the common duct as a routine, even when it appears healthy. In all cases where disease or stones exist, this should be carried out, stones being removed with a scoop, and the duct drained by a rubber catheter sewn in with catgut and removed in about ten days when the stitch gives way and the bile is clear and draining freely.

(4) **Acute catarrhal cholecystitis** is usually present as a complication of "catarrhal jaundice," and is the precursor of chronic cholecystitis, as well as of the acute suppurative and gangrenous conditions met with in the gall-bladder. The gall-bladder will look injected, and, if opened, the mucous membrane will be found to be reddened, œdematous and thickened, while there may be considerable œdema in the submucous coat; occasionally small superficial ulcers may be present. As a result of these changes in the mucous and submucous coats the narrow cystic duct is often obliterated, and the gall-bladder becomes distended by the mucus secreted from its lining.

When the inflammation subsides the duct may become patent, the gall-bladder empty, and the conditions return to normal, but very often, owing to adhesions between ulcerated surfaces and fibrosis in the submucous tissue, the cystic duct becomes permanently obliterated, or so narrowed as to preclude efficient emptying of the gall-bladder, in which case chronic catarrhal cholecystitis supervenes.

(5) **Chronic catarrhal cholecystitis** results from infection from the biliary passages, with consequent œdema and obstruction to the inflow and outflow of bile, and partial or complete blockage of the cystic duct. This hinders or prevents the escape of the mucus secreted by the epithelial lining of the gall-bladder, which, if the obstruction be complete, becomes distended with clear semi-fluid mucus (white bile), a "*hydrops of the gall-bladder.*" Subsequently a series of changes occurs both in the gall-bladder wall and the contents.

Thus the fluid part of the mucus tends to absorb or may escape through a partly-patent duct; bile may regurgitate into the gall-bladder, and, together with the débris and inspissated salts already in the gall-bladder, cholesterin secreted from the inflamed mucosa, and any bacteria present, form the nucleus of one or several gall-stones. Thus cholelithiasis is often associated with and aggravates chronic cholecystitis (p. 752).

The gall-bladder mucosa gradually becomes hypertrophied and thickened, and later tends to desquamate; if a gall-stone is in contact with it, it will ulcerate, becoming replaced by fibrous tissue. Thus, especially if many stones are present, the gall-bladder lining may be destroyed entirely and be replaced by fibrous tissue, so that as this scarring spreads into the submucous and muscular coats these will become thickened, often to a great extent, and contract down tightly around any contents. Thus a thick-walled, shrunken gall-bladder will result in such cases, and is usually associated with many faceted gall-stones, around which it is tightly contracted. Where, however, only one small stone exists, and especially if it is impacted in the cystic duct, the gall-bladder epithelium remains intact and secretes mucus into the lumen, which becomes enormously distended, so that the gall-bladder may contain several ounces of mucus and project below the costal margin, forming a rounded, palpable tumour. At the same time the muscle will attempt to contract to expel the contents, and the wall will thicken to withstand this pressure, so that some hypertrophy of the wall will result. This hypertrophic distended gall-bladder is usually associated with the presence of only a very few small gall-stones. At the same time organisms exist in the gall-bladder contents, or may reach them either through the wall of the bladder via the lymphatics, or by the cystic vessels, in which case secondary infection will be superadded.

A peculiar type of chronic cholecystitis is sometimes seen where no stones are present, and the lining of the gall-bladder looks like a strawberry (the "*strawberry gall-bladder*"). It is of a bright red colour and is dotted with little pip-like yellow spots which are *in* the mucous membrane and consist of a lipoid body which is probably an ester of cholesterol. The wall of the gall-bladder is slightly thickened.

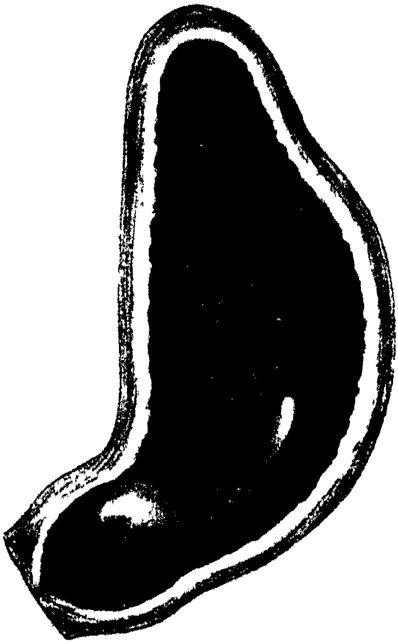


FIG. 264. Strawberry gall-bladder, showing large solitary calculus impacted in the dilated cystic duct.

In any case, therefore, further attacks of inflammation may be expected in the closed sac, as a result of which further deposits will occur, more gall-stones may be formed, and the contents may become purulent (*suppurative cholecystitis, empyema of gall-bladder*). Moreover, the wall will become infected, when adjacent abdominal viscera, such as the stomach, colon, omentum or falciform ligament, will adhere around it and often remain attached; if the inflammation subsides the wall is further thickened and adhesions persist. Perforation or gangrene may occur (*gangrenous cholecystitis*).

It is important from the point of view of operation to realise that the ampulla at the neck of the gall-bladder, which normally lies along the right hepatic and common bile-ducts, generally becomes adherent along the latter. Care must be exercised therefore in removal of the gall-bladder, lest the common duct be cut or torn.

Clinically, chronic cholecystitis gives rise to a fairly definite series of signs, which have only recently been recognised as due to this condition. Chronic indigestion of the "flatulent dyspepsia" type occurring in obese middle-aged people, usually females, should be regarded as indicating the presence of chronic cholecystitis. The condition is often present for years without giving great discomfort, but exacerbations, corresponding doubtless to reinfections, are common, and sooner or later one of these will give rise to acute suppurative or gangrenous cholecystitis.

The onset is usually vague, but there may be a history of an attack of catarrhal jaundice, often years before, from which the digestive troubles date. There is flatulence, and a sense of overfulness and discomfort, seldom amounting to pain, most marked after meals, and in the right hypochondrium. The tongue is furred and the appetite poor, the patient seldom "enjoys her food." Belching and constipation are common. Persistent occipital headache is complained of at times. Examination may reveal rigidity and tenderness in the right hypochondrium, especially on pressure up under the costal margin. If distended, the gall-bladder may be felt as a rounded or elongated swelling, moving down from under the right costal margin on inspiration; in a few cases it may reach well below the umbilicus. If inflamed, it is tender to the touch. The swelling is dull on percussion, and has no resonance between it and the costal margin, is rounded in outline, and moves with respiration. X-ray examination rarely shows a shadow from a calculus, if such be present, but combined with administration of tetrabromphenolphthalein (Vol. I., Ch. XXIII.) it is often of value; for if the cystic duct is blocked no gall-bladder shadow is seen. Should the duct be patent, but much contracted, a faint shadow will be present, often incomplete and reticulate from the presence of one or more gall-stones, which themselves cast no shadows in most cases.

Diagnosis is by no means easy; both appendix dyspepsia, and gastric and duodenal ulcers are simulated in some respects, though the rigidity and tenderness are confined to the right rectus in cholecystitis. If the case is seen for the first time, and an unsatisfactory history is obtained, carcinoma of the stomach may be simulated closely and even diagnosed, unless the long history be elicited. Hepatic cirrhosis and chronic alcoholic gastritis give very similar signs, and can be dismissed only on a careful examination and history, in which the presence of ascites and morning sickness point strongly to alcoholism.

Usually if left, sooner or later an acute cholecystitis supervenes, and there is often a history of previous subacute attacks associated with increase of signs, acute tenderness in the upper abdomen, and perhaps vomiting and constipation for some days.

Occasionally a gall-stone ulcerates (1) into the bowel, when gall-stone obstruction (Chapter XVI., p. 690) may result; or (2) into surrounding adhesions, which shut off the peritoneal cavity, when a localised abscess forms around the gall-bladder, one type of subphrenic abscess (Chapter XIII., p. 543).

It cannot be impressed on the reader too strongly that biliary colic does not occur in chronic cholecystitis, as any gall-stones present are shut into a fibrotic gall-bladder.

Treatment. A full course of hexamine, combined with alkalies to stop dysuria, if necessary, should be given for at least three weeks and often effects a cure provided no stones are present. *Felamine* pills are a useful form in which to administer the drug, and are a combination of hexamine with choleic acid; they should be given, wherever possible, for ten days before any operation on the gall-bladder or bile-ducts. If hexamine fails or stones are present, the treatment consists in laparotomy, when the gall-bladder should be examined; if it is shut off from the biliary passages or thickened in the walls, it must be removed (cholecystectomy). In those few cases where it appears more or less normal, some surgeons urge that drainage should be employed (cholecystostomy), the drain being left in situ for about ten days, or until the bile escapes freely and looks clear and healthy; but cholecystectomy gives more satisfactory results in such cases.

Inasmuch as in the vast majority of cases the gall-bladder is completely, or nearly, shut off by obliteration of the cystic duct, no medicinal treatment is likely to be of value, though cholelith pills are sometimes beneficial.

After operation the diet should be regulated so as to exclude excessive fats and such foods as eggs and chocolate, which are rich in cholesterin. Hexamine may be given with advantage, as the formalin liberated serves to disinfect the bile, and its administration is imperative in post-typhoid cases.

(6) **Acute suppurative cholecystitis** nearly always occurs as an exacerbation of a long-standing chronic cholecystitis where the gall-bladder is occluded from the bile-ducts, and follows secondary infection from the bowel via the lymphatics. Gall-stones are often present in the gall-bladder, and the blockage of a previously patent cystic duct by one of these, usually a large rounded solitary calculus, often may determine the onset of an attack of acute inflammation, the causative organisms then being those dammed up in the infected gall-bladder. It is common in these cases to find only one rounded solitary calculus, and that impacted in the cystic duct.

In the vast majority of cases the gall-bladder is already distended with mucus, and the wall thickened by chronic inflammation (p. 747), but the superadded pyogenic infection renders the contents purulent (though thick pus is uncommon), and causes œdema in the walls, with the formation of new protective adhesions without.

Clinically the onset may be sudden, with pain starting at the umbilicus, and gradually settling in the right hypochondrium, which is acutely tender and rigid, and does not move on respiration.

In most cases there is a long previous history of chronic cholecystitis and the onset is not so acute, the signs gradually increasing in severity for some days as the infection spreads. There is often pain in the back, chiefly in the right subscapular region, and vomiting may be present. Belching and shivering frequently occur, while the temperature is often high, reaching 103° or so.

A tender, rounded mass can be detected usually on palpation projecting beneath the costal margin and having all the characteristics of a gall-bladder swelling. This may be so tender that the patient cries out on being palpated.

Diagnosis is usually easy, but the condition may be mistaken for acute appendicitis with an inflammatory mass, especially if there is visceroptosis, so that the gall-bladder lies low in the abdomen. The mass, however, if connected with the liver, moves on respiration, while the patient's age and history are usually against appendicitis.

Treatment. As no indication can be obtained as to the course of the inflammation, and as, moreover, this seldom settles, immediate laparotomy should be performed. In general, the presence of a tense distended gall-bladder always demands operation.

The mass is packed off from the peritoneal cavity and the omentum stripped from the gall-bladder, when this will be seen to be red, œdematous and tensely distended. Sometimes perforation has occurred, and pus and even gall-stones are met lying around the gall-bladder ; in such a case they must be sponged away before proceeding to cholecystectomy.

Cholecystectomy should be performed, if possible, and a drain of corrugated rubber left down to the stump of the cystic duct for forty-eight hours. Should the patient be very feeble and the adhesions very dense, especially around the neck of the gall-bladder, the stones having been removed, cholecystostomy should be resorted to, instead of excision of the gall-bladder.

If necessary, the gall-bladder can be removed subsequently, though often this is not necessary, as even when the cystic duct appears obliterated, bile will appear ultimately through the tube; the patency of the duct is often re-established as the inflammation subsides.

Some surgeons prefer to adopt expectant treatment as many cases settle and the gall-bladder can be removed some months later; this treatment is not safe unless there is a previous history of chronic infection, as unless the wall is thickened perforation with fatal general peritonitis is likely to occur.

(7) **Acute gangrenous (phlegmonous) cholecystitis** is a condition closely analogous to the preceding, but the infection is mainly in the wall of the gall-bladder, which is usually thickened from previous inflammation. As a result of superadded acute infection the fibrous tissue sloughs, and this may occur locally, when a perforation results, or take the form of a massive gangrene of the whole organ.

Most often gangrene occurs either at the neck or at the fundus, and as adhesions are usually previously present, localised abscesses result; however, should the gall-bladder contents escape into the peritoneal cavity, the signs resemble those met in perforation of a duodenal ulcer, and general peritonitis rapidly supervenes.

This type of infection may occur in either the distended, or contracted, chronically inflamed gall-bladder, and is often associated with suppuration of the contents, which usually contain large gall-stones.

Clinically the onset may be sudden, when there is acute pain, with shock and collapse consequent on perforation and escape of the infected gall-bladder contents into the greater sac of the peritoneum. The signs closely resemble those seen in perforation of a gastric or duodenal ulcer, for which the condition is often mistaken, despite the fact that it usually occurs in an obese middle-aged woman.

There is acute pain in the epigastrium and back, and a rigid contracted abdomen, tender to the touch, with vomiting and constipation. The signs are most marked in the right hypochondrium. The pulse is very weak, rapid and usually collapsible, the temperature raised, except when gangrene or perforation has occurred, and shivering is common.

In less acute cases these signs may come on after a few days' acute epigastric pain and rise of temperature; they often coincide with a momentary relief of both of these features, which synchronises with the disappearance or marked shrinkage of the gall-bladder mass previously felt in the right subcostal region.

In other cases, following on some days with epigastric and dorsal pain, fever and the presence of a gall-bladder mass, tender and of an inflammatory nature, amelioration of pain occurs. This is due to perforation into the adhesions around the gall-bladder causing loss of tension in that viscus; soon a perivesical abscess develops, and the pain returns, the temperature rises, and the mass can be felt to increase in size, often markedly. In such cases a slight tinge of jaundice not uncommonly develops, and may be best noted in the conjuctivæ; bile is found in the urine.

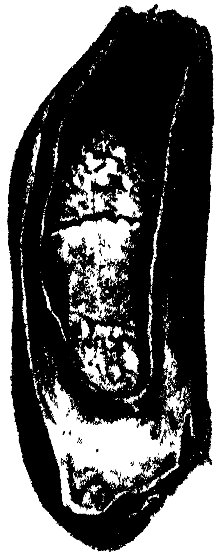


FIG. 265. Acute gangrenous cholecystitis, with a large gall-stone in situ.

Diagnosis. Apart from the cases of acute gangrene with general peritonitis, when perforation of a duodenal or gastric ulcer is closely simulated, this is usually easy. It may be difficult to diagnose between acute suppurative and perforative cholecystitis, but as the treatment is identical such a fine distinction is unnecessary and, moreover, the two conditions usually coexist.

Treatment. This consists in immediate laparotomy and cholecystectomy. The gangrenous organ always needs excision, which, if the neck is perforated, may be no easy operation. Drainage should be employed always, and gall-stones or pus which have escaped into the peritoneum should be removed, if possible; but no prolonged or disturbing search should be made for the former. We are not in agreement with the school of surgery which advocates "wait and see" methods in acute cholecystitis, as we feel that, as in acute appendicitis, an acutely inflamed and obstructed viscus is safer removed than left in the hope that it will settle down and allow operation to be undertaken in a quiescent period.

Torsion of the gall-bladder is rare, but may occur if a long gall-bladder be present, especially if it has contracted a single band like omental adhesion, or if a long peritoneal reflection be present from the liver. The signs resemble acute gangrenous cholecystitis, from which the condition is seldom diagnosed apart from the operation, which is urgently called for.

Cystic Dilatation of the Common Duct. This is a rare condition in which the duct may be either slightly dilated or contain gallons of bile. The cause is not known for certain, but it is probably due to an upset of the neuromuscular arrangements of the duct. There are usually no stones. It is generally seen in young females and gives rise to attacks of pain, vomiting and jaundice, sometimes with fever and rigors. The best treatment is to make a short-circuit between the dilated duct and the duodenum or stomach.

CHOLELITHIASIS

Gall-stones form in the gall-bladder, and less often in the hepatic and common bile-ducts, usually as the result of bacterial infection of the biliary tract supervening on a condition of hypercholæmia, when the alteration in concentration of bile salts consequent on stagnation allows of the deposit of cholesterol and bile pigments in some cases. This with the bacteria and cellular débris forms the nucleus of a stone or may become deposited in the superficial part of the mucosa (strawberry gall-bladder, Fig. 264). This infection is usually of a chronic type, and due most commonly to the Bacillus coli or Bacillus typhosus, though other intestinal organisms such as staphylococci may be met with. It would appear that B. welchii and perhaps in other cases the infection of the biliary passages is the result of direct infection from the duodenum through the ampulla of Vater, and in these cases the pancreatic ducts are also involved.

In other instances, however, infection probably reaches the gall-bladder via the lymphatics or from the portal vein, and where the gall-bladder is shut off this is the only route of infection; probably the B. typhosus always invades the gall-bladder by this route from the ileum and colon via the blood and lymph stream.

Occasionally due to metabolic idiosyncrasy certain stones form by the deposit of substances such as cystines, and in some cases of cholesterol.

Gall-stones form when, as the result of stagnation of the infected bile, usually in the gall-bladder, bacteria and mucus are deposited and form a nucleus around which calcium salts of bilirubin and biliverdin, and to some

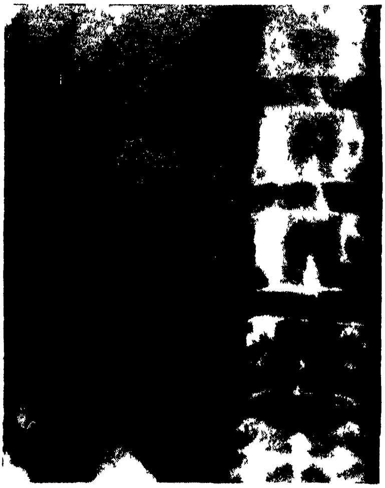
PLATE VI.

A

Gall-stones shown in an X ray Note the clear centres, the gall bladder outline is defined by tetraiodophenolphthalein

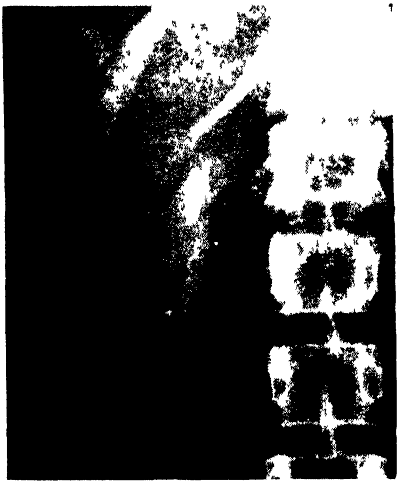
B

Lateral view showing the shadow well anterior to the vertebral bodies



C

Gall-stones showing in an X-ray, apparently in the common duct, but—



D

shown by tetraiodophenolphthalein to be in the gall bladder (antero posterior view) extent these pigments themselves, are deposited, together with a varying amount of cholesterin crystals. Pure cholesterin calculi are uncommon, and, when present, are crystalline, white, glistening, and smooth; if, as is frequently the case, they are multiple, they present facets where they lie against each other. When consisting of bile pigment and salts, mainly the calcium derivatives, the gall-stones are brownish in colour, and vary much in size and number.

Solitary stones are usually oval in shape, and may reach the size of a pigeon's egg, but are generally much smaller; the surface is roughened, but rarely very spiculated and irregular. A rounded solitary stone is sometimes found in the common duct: this type of stone is thought to be due entirely to metabolic changes in the bile without any infection.

Where many stones exist they are much smaller and generally faceted where they lie on one another, but if one such stone escapes via the cystic duct into the common duct and lies there its facets become obliterated by the further deposit of bile salts. These multiple calculi vary much in numbers, and there may be only two or three or many hundreds.

All biliary calculi, therefore, will consist of a soft nucleus of mucus and débris usually containing bacilli, around which bile salts and pigments are deposited in concentric layers.

Usually X-ray films do not show a shadow from gall-stones, as the amount of calcium in the deposited salts is very small, but occasionally a good shadow is obtainable, and then, as might be expected, the stone shows a clear centre and a dense periphery, while a lateral view will show the gall-bladder lying in front of the vertebral bodies (Plate VI.).

This contrasts strongly with renal calculi which have denser centres, and lie on lateral view alongside or behind the vertebral bodies (Vol. I., Ch. XXIII.). If the gall-bladder be X-rayed with tetrabromphenolphthalein (Vol. I., Ch. XXIII.) it will, if the cystic duct be patent, show a shadow deficient in certain areas where the gall-stones lie. These areas vary much in shape and number, but will be less opaque than the shadow of the tetrabromphenolphthalein in the rest of the gall-bladder, except in a very few cases where the stones are rich in calcium salts (Plate VI.).

As already pointed out, chronic cholecystitis or cholangitis precedes the formation of gall-stones, which are therefore most often met with in obese elderly women of sedentary habits, especially multiparæ. Cholesterol is normally present in the bile, but its amount both in the bile and the blood is increased in pregnancy and in certain diseases. It is only stones formed in the gall-bladder itself which contain large amounts of cholesterol. Stones formed in the bile-ducts (usually solitary) consist chiefly of bile pigments and calcium salts.

Biliary calculi may occur, however, in quite young children, and on two occasions we have met with them in the gall-bladder of patients of only three years of age, in one case causing acute cholecystitis. They are also found apparently without any infection in the gall-bladder of patients with familial acholuric jaundice. This type must therefore be due to some metabolic error.

There is no doubt, both from operative and post-mortem findings, that gall-stones may exist for many years and in great numbers, lying dormant in the gall-bladder, unsuspected and causing no symptoms, beyond perhaps a little "flatulent dyspepsia." It is wise, therefore, when doing an exploratory laparotomy to examine the gall-bladder, as a routine, when, if gall-stones are detected, they should be removed, as their presence, combined with the chronic infection, undoubtedly predisposes to the development of carcinoma in the gall-bladder and biliary passages.

Clinical Features. Gall-stones are the result of pre-existing infection and inflammation of the biliary tract, and the signs of chronic cholecystitis will be present therefore for some time, and, indeed, may be the only signs present, even when gall-stones exist. Thus fulness, discomfort and flatulence after meals, anorexia, a dirty tongue and vague pain in the right scapular region, with a feeling of chilliness, are common in such cases (p. 747).

It cannot be impressed too strongly on the reader that " *biliary colic* " will not occur unless the muscle of the gall-bladder, and more especially of the lower end of the common duct, is thrown into spasm and cramp in efforts to expel the stone into the intestine. Should it occur, it is pathognomonic of the presence of gall-stones, though very rarely a ring carcinoma of the common duct may cause colic. Naturally, it is much more common with small stones than large ones.

So long as a calculus or calculi lie quietly in the gall-bladder, or if the muscle wall is damaged and fibrosed as a result of inflammation, and, therefore, incapable of contraction, no biliary colic will occur, and at most vague epigastric and dorsal pain will exist. This pain is often most noticeable after meals, as adhesions are present between the pylorus and gall-bladder, which are dragged on when the stomach is distended. For this reason a barium meal and X-ray examination may give valuable help in the detection of chronic cholecystitis, which always coexists with gall-stones, by showing flattening and distortion of the duodenal cap, with no signs of ulceration in the bowel. while a " tetra " X-ray film will reveal generally that stones are present as less opaque areas in a poorly shadowed gall-bladder ; should much bile salt be present the stones show in a plain X-ray film, presenting the characteristic dense peripheral band around a clear centre.

The larger the calculus the less likely it is that attempts at extrusion will occur, hence the less likely that the patient will complain of attacks of " gall-stone colic."

Similarly, stones lying in the gall-bladder are far less likely to cause colic than those in the bile-ducts, where there is a constant flow of bile ; here any foreign body will tend to be passed on, with the occurrence of frequently recurring attacks of biliary colic.

Biliary colic, above referred to, is the name given to the agonising attacks of pain which result from the spasmodic contracture of the involuntary muscle in the walls of the bile passages in their efforts to extrude gall-stones into the bowel.

It may result from the gall-bladder forcing or attempting to force stones through the cystic duct, but is more characteristically seen as the result of the contracture of the hepatic and common bile-ducts in attempts to extrude a calculus into the duodenum. This task is rendered the more difficult by the narrowing of the common duct as it passes between the head of the pancreas and the second part of the duodenum, and also by the presence of the sphincter muscle guarding the entrance of the duct into the bowel.

Clinically the colic is often preceded by a chilly feeling in the back, which generally persists throughout the attack, and may so increase as to cause a definite " ague," characterised by shivering and chattering of the teeth.

The pain is of an agonising stabbing character, commencing in, and persisting in the right hypochondrium, but lancinating to the back and up to the right scapular region. It does not usually go into the tip of the shoulder. It occurs in spasms, and in each of these increases up to a maximum and then gradually diminishes, unless the stone is passed or slips back into the gall-bladder, when the pain ceases suddenly and a great sense of relief is experienced. The whole attack generally lasts from two to three hours, but the actual spasms seldom exceed a few minutes in duration, though they may succeed each other rapidly. The patient usually sweats freely, may have a raised temperature and rapid pulse, and often belches and retches frequently, though actual vomiting is rare. The abdomen is rigid and contracted, especially in the epigastrium, but the pain is relieved by pressure ; the right subcostal region is tender, and may " feel bruised " for some days after a severe attack of colic.

Diagnosis is generally easy ; occasionally a superficial examination may lead to an erroneous diagnosis of renal colic, perforated duodenal or gastric ulcer, gastric crisis of tabes, or diaphragmatic pleurisy.

Treatment. As in all colic, an injection of atropine sulphate, gr. 1/100, will often relieve the pain immediately by relaxing muscle spasm ; this may be far more efficacious in so doing than morphia, the use of which in quarter-grain doses is usually advocated, and which always, of course, will relieve the pain. If any doubt exists as to the diagnosis, morphia must be withheld, but atropine can be given safely.

Jaundice, a yellow discoloration of the skin and conjunctiva due to escape of bile pigments into the blood stream, is commonly seen in some slight degree after an attack of biliary colic, when the stone is in the hepatic or common ducts. It is uncommon after colic when the stone is in the cystic duct or gall-bladder. Very many cases of gall-stones never have any jaundice at all. This feature is really a complication and not a symptom.

The condition is characterised by a yellowish discoloration of the skin and conjunctivæ, while bile can be detected in the urine and blood serum by suitable tests.

The bile pigments enter the blood as a result of mechanical obstruction to the outflow from the bile passages, or of bacterial infection damaging the walls of the bile capillaries, and in the case of gall-stones both factors probably play a part. Thus jaundice results from the increased infection and damming back of the infected bile consequent on the obstruction due to swelling and œdema of the mucous membrane with spasm of the walls around the stone. If the stone passes, the jaundice is usually slight and transitory, generally disappearing in a few days.

When, however, the stone remains in the duct, especially if it is impacted, and the bile in consequence is dammed up behind it, the jaundice will assume a deep colour and persist. In such cases the colour of the skin may be the brownish-yellow of mahogany and persist for weeks ; but if it is due to an impacted stone it usually varies a little in intensity from time to time as the stone may shift or the œdema of the mucosa vary in amount. In jaundice due to obstruction from carcinoma, on the other hand, the intensity never remits, but tends steadily to increase, and the patient may become almost green.

As a result of the jaundice the skin itches intensely, and the patient scratches continuously, becomes irritable, and cannot sleep. There are anorexia, constipation and flatulence, and a dirty tongue, while the motions are dry and clay-coloured from absence of bile. If, as is often the case, the obstruction is below the opening of the pancreatic duct into the common bile-duct, the fæces are white, copious, bulky and offensive, containing great excess of fats.

In conclusion, before leaving the general consideration of gall-stones, it must be emphasised that an enlarged and palpable gall-bladder, if associated with any degree of jaundice, is seldom a sign of gall-stones, but means that there is obstructive jaundice due to carcinoma, usually of the head of the pancreas. A palpable gall-bladder, without jaundice, on the other hand, means chronic cholecystitis, and is often associated with the presence of one or two gall-stones (p. 748).

GALL-STONES IN THE GALL-BLADDER AND CYSTIC DUCT

Calculi lying in the gall-bladder, where they are formed as the result of chronic infection, do not cause any definite signs, unless there is any attempt to expel a stone through the cystic duct. Inasmuch as the chronic cholecystitis often results in fibrosis and scarring of the muscle of the gall-bladder wall, it follows that the contractile power of this is much diminished or lost, so that very often stones may exist in great numbers without giving rise to any signs beyond those associated with chronic infection of the gall-bladder (p. 747).

As already stated, very often *the cystic duct becomes obliterated* as the result of inflammation, and in this case stones already in the gall-bladder will be incarcerated there, or new stones may be formed from the infected contents, though these are only small and friable as no further bile salts can gain access. If the mucosa is destroyed, then the thickened and fibrotic wall will contract down tightly on the stones, which are held in the contracted and fibrous gall-bladder, whereas, if the mucous membrane remains intact, much mucus will be secreted into the lumen of the gall-bladder, which becomes distended (hydrops). In this case also the wall is thickened, and the stones, of which in this variety usually only a few are present, are often impacted in the neck of the gall-bladder or cystic duct. In both varieties adhesions are common around the gall-bladder, and secondary infection is very likely to occur, giving rise to attacks of suppurative or gangrenous cholecystitis.

In all cases, therefore, where the cystic duct is obliterated either by adhesions or the impaction of a gall-stone during its attempted passage, no further symptoms are likely to arise unless acute infection occurs; but this often does occur sooner or later.

Pain may occur either from dragging on pyloric adhesions after meals, or from feeble attempts at contraction of the diseased gall-bladder, when it is confined to the subcostal region or may pass into the loin. In either case it is seldom severe and comes to be regarded as a chronic " indigestion." In such cases the patient is often unaware that gall-stones exist, and may continue in this state for years with no untoward effects.

Should infection occur, then all the signs of acute suppurative or gangrenous cholecystitis (pp. 750, 751) will be present, and the gall-bladder is usually palpable and tender. Owing to the adhesions general peritoneal infection is rare, and the local abscess which forms may reabsorb and the condition settle for the time being ; but no dependence can be placed on this occurring, and in all cases immediate operation should be undertaken. The gall-bladder must be exposed and opened, stones removed, and either cholecystectomy or cholecystostomy performed ; if the former operation is contemplated, it is often possible to remove the gall-bladder entire and unopened. Should much pus be present around it, this must be sponged away and the area be drained, as well as the stump of the gall-bladder.

Two complications may be met with following acute cholecystitis associated with gall-stones when the cystic duct is obstructed, and a localised abscess forms around :—

(*a*) The abscess may burst externally through the abdominal parietes, and gall-stones be discharged, often through the umbilicus; in this case an **external biliary fistula** will persist, from which stones and mucus will discharge. Gall-stones are said to have emerged from every orifice in the body.

(*b*) The abscess may discharge into the duodenum, the colon near the hepatic flexure, the stomach, or an adherent coil of small bowel, when an **internal biliary fistula** results, the stones escaping into the bowel. No symptoms arise unless a large stone, accumulating a fæcal covering to augment its size, becomes impacted in the lower part of the ileum, when acute obstruction ensues, *i.e.*, gall-stone obstruction (Chapter XVI., p. 690).

Where the cystic duct remains patent, then, under normal conditions, the muscular wall of the gall-bladder will contract and make spasmodic efforts to expel the foreign bodies through the duct. Colic then occurs, and is more marked if the stone is grasped by the cystic duct and forced along it. Such colic is, however, never so severe as when stones are passing down the common duct, and though the pain shoots to the back and shoulder it always can be endured, though it may be severe. Sweating may be present, but shivering is uncommon.

If the stone is so small that its diameter is less than that of the common duct, it will proceed, on being passed into this, without further pain into the duodenum and be voided ; if, on the other hand, it is larger or as large as the common duct, then typical biliary colic will ensue, and all the signs of a stone in the duct will develop. Should the stone impact in the cystic duct, there will be a persistence of dull pain in the hypochondrium and the gall-bladder may become tender and palpable as it distends behind the calculus ; but usually these signs subside in a few days, and the condition passes into that described above.

In other cases the stone, especially if large, slips back into the gall-bladder, when the pain ceases gradually, and no further signs occur till a similar attempt is again made at expulsion. In no case is jaundice ever marked, though slight discoloration of the cornea and even of the skin may be noted, especially if acute cholecystitis supervenes; following the mild colic, bile can be demonstrated in small amounts in the urine and blood serum. Such jaundice is presumably toxic, as no obstruction to bile outflow occurs.

Treatment. If gall-stones are suspected to be present in the gall-bladder, as is usually the case if signs of chronic cholecystitis (p. 747) are observed, then an examination with X-rays and tetrabromphenolphthalein should be made. If the cystic duct is obliterated no gall-bladder shadow will be present, while if patent the clear areas of the gall-stones may be seen in the shadow : an X-ray film without the dye seldom shows a shadow.

If gall-stones are present they must be removed, together with the gall-bladder, if its walls are diseased or the cystic duct not patent; otherwise the gall-bladder may be drained. In all cases the common bile and the hepatic ducts must be explored for the possible presence of calculi. Many surgeons rely on palpation externally, but others open and probe or syringe the ducts. Whichever method be employed it must be carried out thoroughly and any stones found removed, or a biliary fistula and jaundice will develop.

There is no doubt that the presence of gall-stones predisposes to carcinoma of the gall-bladder.

GALL-STONES IN THE COMMON BILE-DUCT OR HEPATIC DUCTS

Calculi are not often formed in the hepatic and bile-ducts, though this may occur in cases of severe infection, when the whole tract, including the bile capillaries in the liver itself, may be packed with numberless small stones. In such cases, unless some are impacted in the ducts, there may be surprisingly little symptoms, and jaundice is slight, but there is often great impairment of hepatic function, so that such cases tend to pass into coma and die following operation, while recurrence of stones is common.

In rare instances a solitary rounded stone forms in the common duct and is thought to be of metabolic origin (see p. 753).

Generally, stones exist in the common duct as a result of being passed into it from the gall-bladder in which they are formed ; hence, where calculi are present in the ducts, they usually also exist in the gall-bladder, which should be explored and drained, or removed at the same time that the duct stones are dealt with.

Many stones may exist in the duct, which can be dilated enormously and its walls thickened to accommodate them, so that the common duct may have the appearance of small intestine. Usually where many stones are present the lowest has become impacted in the lower end of the common duct, and unless this is so very few signs of their presence may arise.

The duct walls are thickened, and its lumen dilated when stones are present in it.

On a small stone being passed from the cystic into the common duct it will pass normally down this into the duodenum, often without any disturbance. If, however, the stone's diameter is so large that it distends the duct, then biliary colic will occur in its passage, and as the lumen of the duct diminishes as it descends, the stone may become impacted somewhere in the lower end of the common duct.

Impaction is more likely to occur (*a*) with large stones ; (*b*) when the wall of the common duct is damaged from previous inflammation ; (*c*) where the stone lies in the duct and gets more bile salts deposited on it from infected bile (a process which will both increase its bulk and mask its facets if such be present) ; and (*d*) where the lower end of the common duct is narrowed from the pressure of any enlargement of the head of the pancreas. Such pancreatic enlargement occurs in chronic pancreatitis, septic and gummatous, and carcinoma (p. 770), all of which will in themselves cause obstructive jaundice, and may give rise to mild biliary colic. It will be seen thus that pre-existing disease in the bile-ducts or pancreas will predispose to the arrest of the stone in the lower end of the duct.

If the stone passes into the duodenum, the colic ceases suddenly, and all is well, but in a few hours a more or less intense jaundice will develop, probably as a result of the damming back of the infected bile behind the stone, and this lasts a day or so, fading gradually.

Impaction of the stone is indicated when there is very severe and almost continuous colic of a very agonising nature, with acute tenderness over the right rectus muscle just above the umbilicus. This pain persists for several hours, intermitting only for very short intervals, and is typical biliary colic, the pain being most intense in the subcostal angle, but shooting through to the back and up to the right scapular region. Sweating and shivering are present and severe, the perspiration often running off the patient in streams, while the teeth chatter and the pulse is rapid and full. After a time, as the musculature of the bile-duct tires, the pain lessens, and ultimately disappears, its place being taken by a dull ache and a feeling of discomfort in the epigastrium ; colic may recur in the course of the next few days, but is seldom so severe. The tender spot beneath the upper part of the right rectus usually persists, and this muscle is unduly rigid. The gall-bladder is not palpable, as it has emptied itself during the colic, and often the extra spasm may pass additional calculi into the bile-ducts, where they lie above the impacted stone.

Jaundice will appear within a few hours of the colic, and is usually severe, the patient's skin and conjunctivæ being bright yellow, which, if the stone remains impacted, will change in the course of some days to mahogany brown, the patient having a deeply bronzed appearance. This persists so long as the impacted stone causes obstruction to the bile outflow and for a few days after its passage or removal ; but, inasmuch as the œdema of the mucosa, the muscle spasm, and also the position of the stone will vary, so the depth of the jaundice usually varies slightly from time to time. This variation is very constant in obstructive jaundice, due to the impacted gall-stone, as is also the impalpability of the gall-bladder. These two signs serve to distinguish this condition from obstructive jaundice due to malignant disease, where there is no variation in the tint of the deep bronzed jaundice and the gall-bladder is distended and palpable. If the stone is impacted above the opening of the pancreatic duct the stools are constipated, dry and clay-coloured, but if, as is usually the case, it is fixed in the ampulla of Vater, just inside the duodenal orifice and below the opening of Wirsung's duct, then the stools are bulky, clay-coloured, contain fat and have an offensive odour. Should bile enter the pancreatic duct acute hæmorrhagic pancreatitis may ensue, while if the stone remains long impacted infection of the pancreatic ducts leads to chronic pancreatitis and carcinoma (pp. 767, 770).

Return of biliary colic may allow the stone to be forced on into the duodenum, or the relaxation of exhaustion may permit of its ascending to a higher level in the duct and temporarily relieving the obstruction of the bile flow. Should, however, neither of these contingencies occur the stone will remain impacted and the jaundice persist, unless ulceration permits the calculus to escape from the bile-duct into the duodenum or into a periductal abscess in the retroperitoneal cellular tissue, both of which complications are rare. Occasionally acute suppurative cholangitis will supervene (p. 750).

If impaction persist more than a few days, then operation must be undertaken for the removal of the stone, even in the face of the slight additional danger of hæmorrhage consequent on the jaundice.

The *diagnosis* from malignant jaundice is easy if attention be paid to the fact that the gall-bladder is not palpable and the jaundice varies in intensity in gall-stone obstruction. In carcinoma a primary growth may be detected, and the liver is usually enlarged and palpable and may be nodular. (See Courvoisier's Law, p. 770.)

From the intense toxic jaundice occasionally met with in pregnancy the diagnosis may not be so easy, but here colic is usually absent and has never occurred in the past, and the patient is very ill and often drowsy. Van den Bergh's test may be of value, if carried out by an expert, in distinguishing toxic from obstructive jaundice.

Treatment. If the patient is seen in an attack of biliary colic this should be treated by injection of atropin gr. 1/100, which not only relieves the pain by relieving the muscle spasm, but may also allow the stone to pass more easily. Morphia may be given if the patient is very exhausted or collapsed and is necessary if the calculus be causing severe pain.

When stones are known to exist in the bile-ducts, or found there at operation, their removal is indicated, as they are not only a source of pain and irritation, and keep up biliary infections, but they tend to give rise to serious inflammatory complications in the liver and pancreas and certainly predispose to carcinoma in the latter organ.

Impacted calculi always must be removed; if possible they should be worked up the duct from behind the duodenum and removed through an incision through the upper part where the common duct lies at the edge of the lesser omentum. This is not always possible, and then the stone must be removed either by incision across the duodenum (transduodenal choledochotomy) or by incising the peritoneum to the right of the bowel and displacing the second part of the duodenum to the left so as to expose the bile-duct lying behind it—an operation made difficult by there being large branches of the superior pancreatico-duodenal artery lying both in front of and behind the duct (retroduodenal choledochotomy) (see p. 762).

The various operations on the gall-bladder and bile-ducts are described briefly at the end of the chapter.

TUMOURS OF THE GALL-BLADDER AND BILE-DUCTS

(*a*) *Benign neoplasms* of the biliary tract are so rare as to be only of interest to the pathologist; papilloma, adenoma and fibroma have been reported.

(*b*) *Malignant neoplasms* commonly take the form of a *columnar-celled carcinoma*, and this tumour is not so very uncommon, being usually associated with long-standing infection of the biliary passages and gall-stones.

These carcinomata are liable as the result of previous chronic inflammation to be squamous in type, the mucous membrane having undergone metaplasia.

Carcinoma, as might be expected therefore, usually commences in the gall-bladder, and is met with in elderly adipose women, starting more often in the fundus than the neck of the viscus, and, like gall-stones, being about four times commoner in females than in males.

It must be remembered, however, that in a section of the normal gall-bladder there are deep crypts, and these may give the mucous membrane and epithelial cells the appearance of invading the muscle underneath. This is especially so if the gall-bladder is chronically inflamed, and may cause a marked resemblance to carcinomatous change.

Carcinoma of the Gall-bladder. There are nearly always gall-stones present in association with this condition, and very often these stones appear to be markedly radioactive. The risk of a patient with calculous cholecystitis developing a carcinoma of the gall-bladder is therefore quite definite.

Clinical Features. Following on a long history of cholecystitis a rounded and often nodular mass appears in the region of the gall-bladder and increases steadily in size. It is usually painless and does not move so freely as an enlarged gall-bladder, the definition in outline of which is lacking in the neoplasm. Later, when the liver is invaded, persistent pain may be present and jaundice appear, though jaundice is sometimes the first and only symptom. Secondary nodules may come early at the umbilicus. The condition is often unsuspected, even at operation, when only a microscopic section of the wall of a thickened gall-bladder reveals that carcinoma is present.

Treatment. This consists in cholecystectomy, with, if necessary, resection of the invaded adjoining portion of the liver. Should the condition be too advanced no operation should be attempted.

In view of the prevalence of carcinoma, as revealed by microscopy, in the walls of chronically inflamed gall-bladders, most surgeons perform cholecystectomy in every case where the wall of the gall-bladder is obviously thickened.

Carcinoma of the Common and Hepatic Ducts. This is rarely seen, and usually takes the form of a ring stricture, which, if situated at the lower end of the common duct, may be mistaken on palpation for an impacted stone.

The bile-duct is distended and thickened above the stricture, and there is intense jaundice, with gradual enlargement of the liver and a palpable gall-bladder.

The condition may be mistaken for carcinoma of the pancreas or an impacted gall-stone. It occurs in four situations :—

(1) At the ampulla, when all the ducts are distended with bile and pancreatic juice.

(2) Between the ampulla and the cystic duct. This leaves the pancreatic duct free from involvement.

(3) At the junction of the cystic and common ducts, when the gall-bladder is full of mucus and the common duct with bile.

(4) In the hepatic duct, when the gall-bladder and common duct will be empty.

Treatment. It may be possible to excise a ring carcinoma and perform an end-to-end anastomosis of the duct, but should this not be practicable relief of the jaundice may be obtained by performing an anastomosis of the distended gall-bladder to the duodenum or stomach.

Malignant jaundice is a term applied to the intense bronzed jaundice resultant on the obstruction of the biliary passages by carcinoma, either in the liver or bile-ducts. The jaundice never varies in intensity and is combined with the presence of an enlarged and palpable gall-bladder. After a time it tends to become greenish in colour.

If due to multiple secondary deposits the liver is large and tender, nodules can be felt and ascites is present, and in such a case no surgical procedures will benefit the patient.

If, on the other hand, the jaundice is due to carcinoma of the pancreas or bile-ducts, then relief can be obtained from the distressing symptoms of jaundice (p. 755) by performing cholecystoduodenostomy or cholecystogastrostomy.

OPERATIONS ON THE GALL-BLADDER AND BILIARY PASSAGES

In all operations on the biliary tract it is advantageous to prop the back forward in the dorsilumbar region, either by means of a rubber bag, wooden blocks, or best by means of raising an adjustable bar on the operating table. This manœuvre rotates the liver forwards and makes the gall-bladder and ducts more easily accessible.

Various incisions are in use to approach the gall-bladder, those most commonly used being :—

(*a*) A *right paramedian incision* is used by many surgeons.

(*b*) *Mayo Robson's incision,* where a vertical incision is made over the centre of the right rectus in its upper half, and the anterior sheath having been incised, the muscle is either retracted outwards or split in the direction of its fibres. In obese subjects, and where more room is required, the upper end of the incision may be prolonged inwards parallel to the costal margin, and the lower outwards across the rectus muscle.

(c) *Kocher's incision*, which is made parallel to and an inch below the right costal margin, gives an excellent exposure of the gall-bladder and ducts, and often allows of these being pulled up into the wound. The rectus is cut across, and usually the eighth and ninth dorsal nerves have to be sacrificed.

(d) *A transverse incision* is sometimes employed, extending from the ninth costal cartilage, but does not give such a good exposure of the ducts as Kocher's incision.

(e) *A trap-door incision*, consisting of a right paramedian with a transverse cut out across the right rectus, which is divided at the level of the umbilicus, and so permits of a triangular flap hinged on the costal margin being reflected, has much to recommend it, but is not much used in this country.

Whichever route is used, the abdominal wall must be sutured in layers, and if this be done, post-operative hernia is rare; careful examination at St. Thomas's Hospital for many years shows an incidence of just under 1 per cent., this being the same in all types of incision.

When the peritoneum is opened the gall-bladder is isolated and packed off from the surrounding viscera by sterile gauze plugs, the pylorus being previously explored for the presence of an ulcer. The finger should be passed into the foramen of Winslow, and the common and hepatic ducts carefully palpated between the finger and thumb, which must also explore the head of the pancreas and the duodenum. Many surgeons are satisfied with a negative examination of this nature, but others open and explore the common duct as a routine, usually with a probe; others demonstrate its patency by squirting sterile water through it into the duodenum.

In any case, before proceeding to open the bile-duct, which is lying in the free edge of the lesser omentum to the right of the hepatic artery and in front of the portal vein, it must be isolated and freed from surrounding fat. Only catgut should be used in suturing the walls of the bile tract, as stones are very apt to form on non-absorbable sutures.

Choledochotomy consists in making a vertical incision into the common or one hepatic duct, through which the ducts can be explored with a soft probe, and their patency demonstrated.

Gall-stones may be removed through such an incision, and if these are present the duct always must be drained.

Drainage is secured by stitching a rubber tube into the lumen of the duct and removing it, when the suture gives way in about ten days. If the duct is healthy the wall may be sutured by interrupted Lembert sutures, but a drain should be left down to it for forty-eight hours, as leakage is liable to occur.

When a stone is impacted in the retroduodenal portion of the common duct or ampulla of Vater, efforts should be made to dislodge it and force it up to the foramen of Winslow, where it can be removed; sometimes it may be pulled up gently with a scoop. Should this not be possible, the stone must be removed either (1) by a **trans-duodenal choledochotomy**, when no attempt need be made to sew up the incision into the duct through the posterior duodenal wall, but very careful suture of the incision in the anterior duodenal wall is essential to prevent formation of a duodenal fistula; or (2) by mobilising the duodenum from its outer (right) side by incising the peritoneum and displacing the bowel to the left, until the bile-duct is exposed as it lies behind it (**retroduodenal choledochotomy**). In this case the superior pancreaticoduodenal artery nearly always causes severe hæmorrhage, hard to control in so deep a wound.

Cholecystostomy is to be employed when the gall-bladder wall is apparently normal in thickness and structure. The fundus having been incised, the contents are evacuated without soiling the peritoneum, and the cystic duct explored and found patent; a rubber tube is then inserted and stitched to the incision with catgut. One or two purse-string sutures are now inserted around the incision in the gall-bladder, which is invaginated by gentle pressure on the tube, the purse-strings being drawn tight in succession; in this way an inverted "ink-well" is obtained, and on withdrawal of the tube in about ten days, peritoneal surfaces will be apposed and heal without formation of a biliary fistula.

Cholecystectomy. The cystic duct and artery, having been isolated, are freed from the common and hepatic ducts and clamped and divided, which is no easy task when acute inflammation is present. If possible the peritoneum is dissected off the gall-bladder, which is freed from the liver from its neck up to the fundus and removed, the peritoneum being stitched over the bare area left. In many cases it is easier to start the dissection from the fundus, but there is some danger of damaging the common duct if the neck and cystic duct are not carefully identified and isolated before division.

Should the common duct be damaged, it must be repaired at once.

Drainage by a corrugated rubber drain passing to the stump should be employed for forty-eight hours, as there is a liability for leakage of bile to occur.

Cholecystectomy should be resorted to in all cases where the wall of the gall-bladder is obviously thickened or diseased, and where the cystic duct is obliterated.

Persistence of symptoms in the form of attacks of pain and even jaundice is sometimes seen after a cholecystectomy. These usually disappear spontaneously after some months. It is difficult to say what they are due to. Possibly the bile is thick and muddy and there may be some spasm of the sphincter of Oddi.

Cholecystenterostomy consists in opening the fundus of the gall-bladder and anastomosing it by a series of continuous sutures, either a single row of Connell sutures or by two layers, to an incision in the duodenum (cholecystoduodenostomy), the anterior wall of the stomach (cholecystogastrostomy, an operation which is at present more popular than the other two), or the upper end of the jejunum (cholecystenterostomy). The operation is usually undertaken for the relief of obstructive jaundice from stenosis of the common duct, often from carcinoma in the pancreas, but it is also advocated that a cholecystogastrostomy should be done as a cure for gastric ulcer (Chapter XV., pp. 620 and 650).

Operations on Jaundiced Patients. Deep jaundice undoubtedly adds somewhat to the risk of an operation on account of the patient's toxic condition, while it should be remembered that a tube in the bile-duct or gall-bladder drawing the bile away leads to loss of fluid and loss of chlorides and may by itself cause exhaustion and wasting. Extra fluid should therefore be supplied in every possible way. Deep jaundice (of a green cyanotic colour) is always liable to pass into a condition of failure of the liver function with vomiting, drowsiness, coma and death. The liver function may be estimated by the lævulose tolerance test. In these cases intravenous infusion of glucose combined with blood transfusion may help.

Excessive tendency to hæmorrhage accompanies jaundice, and may be partially controlled by the pre-operative administration of vitamin K. If a jaundiced patient appears to be oozing unduly, calcium is usually of little use, but a blood transfusion may be given.

After an operation in a deeply jaundiced patient, if the obstruction to the bile flow is successfully removed. the jaundice may nevertheless be three or four weeks before it disappears ; but the itching and the bile in the blood serum should disappear very soon.

Biliary fistula following operation nearly always means that a stone has been overlooked in the common bile-duct, so that there is less resistance to the bile flow through the wound than into the bowel. Rarely it may result from stricture of the duct after ulceration around an impacted stone, chronic pancreatitis, or damage to the duct at operation.

When a stone is present treatment consists in a further operation for its removal. Strictures are more difficult to deal with, and if the gall-bladder is present some form of cholecystenterostomy offers the easiest solution ; otherwise attempts may be made to dilate the stricture, or divide the bile-duct above and implant the upper end into the duodenum or stomach.

Cases are also seen after operations or injuries where the bile-duct has been completely destroyed and all the bile runs out into the surface. To remedy this by operation a plastic procedure on the duct may be attempted, or a flap of duodenum turned up and sutured into a tube to meet the stump of the bile-duct. Better still, the whole fistulous tube may be dissected down to the bile-duct preserving it intact and the tube may then be implanted into the duodenum.

DISEASES OF THE PANCREAS

Surgical Anatomy. The pancreas is a retroperitoneal organ, and is an active gland secreting a digestive juice which contains a ferment capable of producing marked destruction and digestion in tissues with which it comes in contact. Necrosis of fat is set up wherever this juice spreads, while the irritant nature of the secretion, when it escapes into the peritoneum, causes an aseptic peritonitis, with a paralytic condition of the bowel. The necrosis of tissue set up by this secretion is especially liable to lead to hæmorrhage.

Normally the pancreatic secretion passes down the pancreatic duct and the accessory duct of Santorini to reach the duodenum, and sometimes, if the main duct of Wirsung is obstructed, this accessory duct is sufficient to convey the juice into the bowel. If for any cause these ducts are obstructed and the secretion becomes dammed back into the gland, necrosis of the gland substance ensues, with hæmorrhage, while the secretion escapes into the tissues round and splits up the fat with which it comes in contact into fatty acids, this giving rise to areas of *fat necrosis.*

In addition to this another portion of the pancreas, the cells of the islets of Langerhans, pour an internal secretion (*insulin*) into the blood, which controls the carbohydrate metabolism, and the absence of which gives rise to a form of diabetes.

When the pancreatic function is interfered with in disease, characteristic changes are often found in the fæces; an excess of undigested fat is present therein (*steatorrhœa*), which makes the stools soft and whitish; undigested fibres of meat, etc., will be found in them, while the motions are excessively bulky.

The situation of the pancreas, with its head lying in the concavity of the duodenum, and its tail reaching across to the spleen and crossing the spine opposite the disc between the first and second lumbar vertebræ, is such that its diseases are liable at once to involve other important abdominal organs in the neighbourhood, while the greater part of its body is brought into intimate relationship with the lesser sac of the peritoneum. The fact that its main duct and the common bile-duct open into the duodenum by means of a common opening at the ampulla of Vater renders disease of the biliary apparatus especially liable to affect the pancreas, while in most cases the common bile-duct passes actually through the substance of the head of the pancreas. An accessory pancreas is occasionally found attached to any of the abdominal organs in the immediate neighbourhood.

In approaching the pancreas at operation, there are several routes :—

(*a*) Anterior routes: (1) above the stomach through the lesser omentum; (2) below the stomach and through the great omentum; (3) below the transverse colon and through the transverse mesocolon.

(*b*) Posterior route: by an incision below the last rib, and very similar to that used for the kidney. This is entirely extraperitoneal, but it is only the head or the tail of the organ which can be reached this way.

Injuries and Wounds of the Pancreas. These are discussed on p. 520 in connection with abdominal injuries in general. The pancreas is hardly ever injured except in conjunction with other abdominal organs.

PANCREATITIS

This occurs in two forms, acute and chronic pancreatitis. In either case there is a close connection with inflammatory diseases of the biliary apparatus, which may be looked upon as predisposing causes.

Acute Pancreatitis. This is a very acute and grave disease which, inasmuch as it appears in several forms, has had several different names given to it; thus it has been described as *acute hæmorrhagic pancreatitis*, *acute suppurative pancreatitis*, and *acute gangrenous pancreatitis*, but the probability is that these are all three stages in one disease, which depend very largely upon the virulence of the attack. In nearly every case the condition is associated with gall-stones or inflammation of the gall-bladder, and it is possible, therefore, that infection usually reaches the gland by travelling up its duct; it may be that bile getting into the pancreatic duct owing to blockage at the ampulla of Vater assists to carry this infection up, while the presence of bile in the pancreatic duct probably sensitises the pancreatic ferments before they reach the bowel. In other cases it is possible that infection arrives via the lymphatics, by means of the blood stream or by direct invasion, owing to the pancreas becoming eaten into by a chronic gastric ulcer. A few cases apparently have been due to injury, though this always must be accepted cautiously, as it will be seen that hæmorrhage into and around the pancreas does not mean necessarily that an injury has occurred. The presence of pancreatic calculi (see p. 770) also predisposes towards acute pancreatitis. Many authorities consider that infection plays only a secondary or no part in this condition, and regard the disease as due to activation of the pancreatic ferments within the gland as a result of the presence of bile or blood.

There is however little doubt that the hæmorrhage often found in the gland substance is the result and not the cause of the disease. In many cases a hæmolytic streptococcus has been found in the bile.

In the early stages the pancreas usually becomes swollen, œdematous, red or purple, and infiltrated with blood, there sometimes being extensive hæmorrhages into the tissues immediately round. This hæmorrhage is probably due to erosion of the tissues by the activated pancreatic juice, which has escaped from its normal habitation. while the blood also tends to activate any pancreatic ferments present. Even large vessels may be eroded and profuse hæmorrhage occur ; sometimes free blood is found in the peritoneum. It is said that a hæmorrhage of this kind is sometimes seen in chronic alcoholics (*pancreatic apoplexy*), but the possibility is that this is of infective origin. The liberation of pancreatic ferment gives rise to extensive fat necrosis, as shown by numerous firm white areas in the fat, especially in the mesentery, omentum, retroperitoneal tissues round the pancreas, and even in the abdominal wall (see also p. 766), and this is usually the first thing noticed when the abdomen is opened. An effusion occurs into the lesser sac and the peritoneum is reddened and the bowel distended. In many cases death occurs within two or three days, but should the patient survive, or the process be less virulent, suppuration will occur within the pancreas, scattered foci of pus and necrosis being found throughout its substance. In some instances the whole or greater part of the pancreas will become gangrenous and be found lying as a slough in a bed of pus. The swollen and infiltrated pancreas will press upon the cœliac plexus.

Cases are occasionally seen of a less virulent type, where after a week or ten days of subacute illness, a large abscess forms (*pancreatic abscess*) ; this lies partly in the pancreas, while its wall is partly formed by matting of the surrounding tissues. It even may occupy the lesser peritoneal sac or subphrenic or renal regions. Such a type of case is far less acute than the fulminating ones, and may well be regarded as a subacute pancreatitis.

Subacute cases have often followed typhoid, influenza or mumps.

Clinical Features. This condition usually comes on very rapidly and is very acute ; it is most commonly seen in alcoholic, stout middle-aged men, or more rarely women, giving rise to the most intense epigastric pain, which sometimes passes through to the back and both loins and is accompanied by profuse vomiting, usually bile-stained, and a marked degree of collapse. There is often a previous history of indigestion or gall-stones. Abdominal distension soon sets in, especially of the epigastrium, where there is acute tenderness and often rigidity ; tenderness is very constantly present in the subcostal angle on the left side at the outer edge of the erector spinæ muscle and may also be present in the loins after a few hours ; hæmatemesis is sometimes seen and constipation is marked. The pulse becomes rapid and running, and the temperature is subnormal or only slightly raised. An important feature which is frequently present in these cases is a peculiar lividity or blueness of the patient, which is thought to be due either to interference with the action of the diaphragm by the inflamed pancreas lying upon its crura or to the presence of a septicæmia. In some cases a slight icteric tinge is present, while it is not uncommon for an ill-defined mass to be felt in the position of the pancreas: this is acutely tender, and resonant on percussion. Owing to interference with the islets of Langerhans glycosuria is often present. After 48 hours or so a discoloured patch may appear in the lumbar region below the last rib.

Loewe's reaction is frequently of value in this condition. To test this, 5 minims of 1/1000 adrenalin solution are dropped into one conjunctival sac, and another 5 minims in three minutes' time. In a normal person there is no change, but if the reaction is positive a dilatation of the pupil should occur within half an hour. This is a sign of interference with pancreatic function. The amount of diastase present in the urine is often increased as much as ten times, while glycosuria is often present; this "diastase reaction" is thought by some to be of very great diagnostic import.

In most cases the condition is fatal within a few days, but should the patient survive, a pancreatic abscess is likely to form within a week or so, when the temperature will rise higher and a mass will be felt. If ultimate recovery occurs the patient is likely to be left with a damaged pancreatic function and possibly with diabetes. There is thus considerable likelihood of further indigestive troubles requiring careful attention to diet. Recurrent attacks of acute pancreatitis getting more and more severe are not uncommon.

Death in the early cases is usually due either to intense toxæmia or to septic peritonitis, which is very likely to set in.

The differential diagnosis is discussed on p. 726. The condition most closely resembles acute obstruction, owing to the vomiting, epigastric distension, subnormal temperature and toxæmia.

Treatment. (*a*) The majority of surgeons hold that the only hope of recovery consists in instant laparotomy, and in many cases it is not until this is done that the diagnosis is made for certain. The abdomen is opened in the epigastrium by drawing aside the right rectus, when, if the condition is present, the characteristic lemon-yellow spots of fat necrosis will be noticed at once. There may be blood-stained fluid in the peritoneum, and the lesser sac and the pancreas will be felt to be swollen and indurated. The lesser sac is opened between the stomach and transverse colon, and a large drain inserted, care being taken to protect the peritoneum with packing, while necrosed portions of pancreatic tissue, if seen, are removed. Should the gall-bladder contain stones, these should be removed and the gall-bladder drained, similar treatment being adopted in those cases when the gall-bladder is obviously inflamed. The patient's chances of recovery are greater if the pancreas itself is not incised or drained unless an abscess is present.

At the end of the operation an ounce of 5 per cent. solution of magnesium sulphate may be injected into the duodenum to relax the sphincter of Oddi. The vomiting and general toxæmia will often be much improved either before or after operation by the use of insulin and glucose. These may be given as described in Ch. I., Vol. I.

If an abscess is present this must be drained, care being taken to prevent infection of the peritoneum, and these later cases with abscess formation do well.

In all cases the condition of the gall-bladder and bile-ducts should be examined, and if the patient's condition permits of it, stones should be removed and the gall-bladder be drained.

Other methods of approaching the pancreas, which are less satisfactory, are :—

(i) By dividing the small omentum above the stomach or opening the transverse mesocolon ; and

(ii) The retroperitoneal method, where the organ is approached from the back, below the last rib.

The after-treatment is that of any other acute abdominal operation (see p. 511).

After these operations secondary hæmorrhages are liable to occur owing to the vascularity of the organ and erosion of vessels by the digestive action of the pancreatic juice. This is most common about the tenth or twelfth day when the sloughs are separating. The skin round the drainage tube is liable to become severely digested if not protected. Large portions of necrosed pancreatic tissue come out through the wound occasionally—the tube therefore should be left in for some time (four to eight days).

(*b*) Some surgeons believe that if the diagnosis can be made for certain, the patient's chances (poor though they are) are better if no operation is performed, and this is especially so in cases due to conditions *not* associated with biliary infection. The patient must be kept on a fluid diet, and given morphia or atropine for pain, while hexamine is valuable in these cases. A mass often forms in the lesser sac, but absorption usually occurs without surgical interference.

Chronic Pancreatitis. This is a common condition which is nearly always associated with gall-stones or cholecystitis ; especially is it seen where a gall-stone has been impacted in the ampulla of Vater and the pancreatic juice dammed back. Duodenal catarrh and duodenal ulcer are also causes, while the condition may be accompanied by pancreatic calculus (see p. 770).

An excessive growth of fibrous tissue occurs giving rise to a condition of cirrhosis of the gland, the cirrhosis being either intercellular or interlobular, while the secreting epithelium becomes damaged and is shed. The head of the gland is usually the part affected, and it becomes hard ; sometimes it is enlarged, and at other times shrunken, while lobulation is present. The condition may feel very like malignant disease, especially if the head is swollen. The swelling is seldom large enough to be felt on external examination. The islets of Langerhans may be involved or may escape. Diffuse *gummatous infiltration* of the head of the pancreas is sometimes seen.

Clinical Features. These are vague, and are naturally accompanied by and intermingled with those of any associated causative condition, such as gall-stones ; thus there may be a typical history of biliary colic, and often a past history of gall-stone obstruction of the bile-duct (see p. 758). In many cases the symptoms are those of vague epigastric discomfort and aching with perhaps local tenderness ; loss of appetite, flatulence, and loss of weight occur. Signs of pancreatic inefficiency will be present, with profuse, pale, offensive stools and steatorrhœa ; the stools are often hyperacid. Slight jaundice is sometimes present which tends to become deep as the disease progresses, due to partial and increasing obstruction of the bile-duct, while wasting and anæmia are often marked, and occasionally the condition gives rise to pancreatic diabetes. A "pancreatic reaction" has been described by Cammidge in the urine, but this is probably less reliable than Loewe's reaction (see p. 766). In many cases the differential diagnosis between this condition, carcinoma of the head of the pancreas and an impacted gall-stone is impossible, and even when the abdomen is opened it may be difficult to distinguish the condition from the former of these diseases. Many cases run a slight continuous temperature.

Treatment. The treatment largely consists in removing the cause of the condition, and if it has not progressed too far a certain amount of improvement in pancreatic function may then be expected. Thus in most instances gall-stones will have to be removed from the gall-bladder or bile-duct or pancreatic calculi excised. If no cause of this kind is present the gall-bladder and bile-ducts must be drained. This may be done either by cholecystostomy or, better, by cholecystogastrostomy ; relief of the jaundice can be obtained by this means.

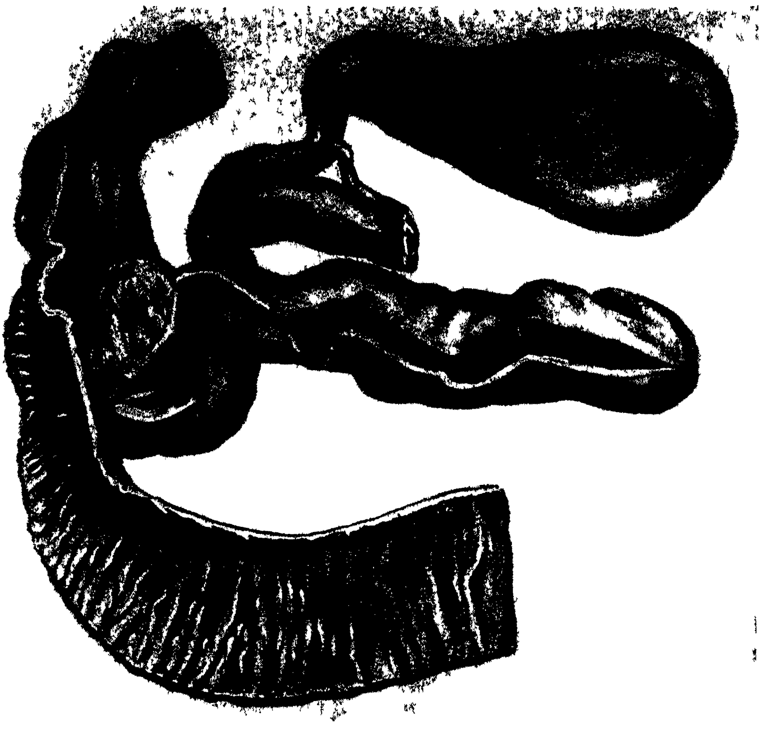


FIG. 266. Duodenum, gall-bladder and pancreas, showing great dilatation of the pancreatic duct due to carcinoma of the head of the organ.

Pancreatic Cysts. These cysts may be false or true.

(A) *False Cysts.* False cysts are really accumulations of fluid in the lesser peritoneal sac, and in the majority of cases they are traumatic in origin ; often they are due to actual tearing or bruising of the pancreas, so that the exuded fluid fills up the lesser sac. This specially follows minor degrees of violence or blows with blunt instruments. In the case of such an injury, after ten days or so a swelling having the characteristic clinical features of a pancreatic cyst will appear (see p. 769). Occasionally suppuration will occur in such a collection, while the fluid usually contains pancreatic ferments.

(B) *True Cysts.* The origin of these is uncertain ; they are rare and are probably due to a combination of obstruction of the pancreatic duct with a chronic inflammation of the epithelium, preventing reabsorption of the secretion ; on the other hand, they may be new growths analogous to ovarian cyst-adenomata. Chronic or subacute pancreatitis plays a part in their formation. These cysts are epithelial-lined and contain a large quantity of turbid, brown-coloured fluid often mixed with old blood, odourless, alkaline, albuminous and apparently containing a ferment, which will produce a digestive action upon starch, fat and albumen. The cysts are unilocular or multilocular, may become very large, and usually arise in the caudal half of the pancreas. Sometimes they actually rupture into the lesser sac, while they rapidly become adherent to surrounding structures. Ulceration occasionally causes the bile-duct to open into the cyst. It must be remembered that congenital cysts and hydatid cysts are occasionally seen in this situation.

Such a cyst starts immediately behind the stomach ; as it increases in size it extends forwards towards the anterior abdominal wall, and it may do this in three different ways :—

(1) Most commonly it bulges forwards between the stomach and transverse colon, which are pushed respectively upwards and downwards.

(2) More rarely it projects forwards below the liver and above the stomach which is pushed downwards, while the cyst carries the lesser omentum in front of it.

(3) More rarely still the cyst passes between the two layers of the transverse mesocolon and presents itself below the transverse colon.

Clinical Features. These cysts usually occur in men of middle age. They give rise to vague symptoms until they become large enough to cause pressure, and then the symptoms will depend upon which organs receive the pressure ; thus indigestion, vomiting, shortness of breath, jaundice or constipation may all be the first symptoms. Loss of weight is usually marked as the pancreatic function is disturbed, while the patients often have an unhealthy-looking, sallow skin.

Sooner or later the cyst can be felt as a round, tense, fluctuating swelling, deep in the abdomen, not moving on respiration, sometimes with transmitted pulsation from the aorta and appearing in the neighbourhood of the umbilicus. The swelling itself is dull on percussion, but there will be neighbouring bands of resonance due to the stomach and colon, whose situation will depend upon which of the three positions described above the cyst is taking up. Its relation to the stomach can be demonstrated by distending the latter organ with air.

Occasionally such cysts are distinctly to the left of the abdomen, especially if they arise towards the tail of the gland ; they then may resemble an enlarged spleen.

There should be little difficulty, by means of a pelvic examination, in distinguishing them from ovarian cysts ; however, they may resemble closely mesenteric cysts or hydronephroses. The latter condition should be discriminated at once by means of a complete urinary investigation (see pp. 809 to 816).

Treatment. This consists in laparotomy and exploration of the cyst, which is carefully exposed by incising whichever omentum seems the most convenient, but care must be taken not to damage large blood vessels. If the cyst arises in the tail of the gland it may be possible to enucleate it completely, but if it is in the head or body it is highly unlikely that enucleation will be possible, and in most cases drainage will be the best treatment, the contents first being drawn off with a trocar and cannula. Probably the best procedure is to open the sac and marsupialise it by stitching its wall up to the anterior abdominal incision, which is closed around a tube. Slow obliteration by granulations will occur, which may be assisted by the insertion of gauze plugging. If marsupialisation is impossible, the peritoneum is packed off and the cyst drained. In many cases it is wise to perform this drainage through a counter-incision in the loin. Permanent sinuses occasionally follow either of these procedures, while the discharge proves highly irritating to the skin, which its ferment digests, so the skin must be protected by an ointment made up with paraffin rather than any form of animal fat. Other procedures have been adopted, such as draining the cyst into the duodenum by means of an intestinal suture.

Cases of pancreatic cyst always should be operated on ,as otherwise they will prove fatal in time.

Pancreatic Calculus. These are nearly always the result of infection and inflammation of the gland, and are frequently accompanied by gall-stones. They give rise to marked inflammatory changes in the pancreas, both acute and chronic, and by their irritation may cause the onset of malignant disease. They usually consist of carbonate of calcium and give rise to colic, rather resembling biliary colic save that the pain is nearer the midline, while all the symptoms of chronic pancreatitis may be present. If large in size, they may block both the main pancreatic duct and the common bile-duct and thus cause jaundice. The condition is not often diagnosed, but if it is the stones should be removed by opening the abdomen, incising the pancreas down to its duct and finally suturing it.

Carcinoma of the Pancreas. Though sarcoma, fibroma and endothelioma have been described very rarely in this organ, carcinoma of the pancreas is by no means uncommon in patients between forty and sixty. Secondary growths may occur in connection with any other form of abdominal carcinoma, while primary carcinoma of the pancreas is of the spheroidal type, is markedly fibrous, and usually occurs in the head of the organ, where it gives rise to a hard oval mass right at the back of the abdomen. It rarely can be felt from outside, except in very thin patients in the later stages. The liver and glands in the hepatic tissues are soon implicated.

In many cases it produces only very vague symptoms until the growth commences to press upon the common bile-duct, when intense jaundice suddenly sets in. This jaundice is deep, the patient becoming of a greenish colour, persistent and unvarying; loss of appetite, energy and weight rapidly occur. Pain is often remarkably absent; when it occurs it is in the left side of the epigastrium, and goes through to the back of the chest. Distension of the gall-bladder and enlargement of the liver also occur. In the later stages, as well as jaundice, pyloric obstruction with vomiting may set in, while pressure upon the portal vein will occur and give rise to ascites. The inferior vena cava may be obstructed and cause œdema of both legs.

The *persistent obstructive jaundice*, which is often practically the only symptom for some time, is of importance, as this is also the chief symptom of obstruction of the common duct by a gall-stone. In the latter case there is likely to be more marked pain, but the two conditions usually can be distinguished by a useful rule known as *Courvoisier's Law ;* this states that in obstructive jaundice due to carcinoma of the head of the pancreas the gall-bladder is distended and palpable, while when the jaundice is due to an impacted gall-stone the gall-bladder is shrunken and impalpable. This rule is nearly always true, though an obvious exception will occur when gall-stones are impacted both in the common duct and in the cystic duct, for here there will be obstructive jaundice, while the gall-bladder will be tensely distended with mucus.

Carcinomata or very rarely adenomata of the pancreas which involve the islets of Langerhans have in a few instances been found to give rise to excessive activity of the islets leading to *hyperinsulinism* and marked reduction in the blood sugar with *hypoglycæmic symptoms.* Such a condition may of course also be due to the influence of the anterior part of the pituitary, the adrenals, or changes in the liver, all of which must be considered as possible causes.

The symptoms which arise are :—

(1) Attacks of nervous or gastric disturbance, especially during fasting, with faintness, twitchings, irritability, confusion, and even coma.

(2) Marked diminution in the blood sugar percentage.

(3) Rapid relief if large amounts of glucose are given.

These symptoms if due to pancreatic influence can be cured by removal of tumours, or of islet tissue or by resection of the tail or body of the gland.

Treatment. Removal of such a growth is rarely practicable. Two or three cases have been reported, but the operation is difficult and dangerous.

On the other hand, the discomfort and itching associated with the intense jaundice can be removed, and the patient's digestive powers and general comfort much improved and his life prolonged, by performing a cholecystogastrostomy or cholecystenterostomy so that the bile can pass into the stomach or bowel. In some cases even a cholecystostomy has been performed; this will lead to permanent biliary fistula. Few patients will live for more than a year, and usually death occurs within eight months.

DISEASES OF THE SPLEEN

Surgical Anatomy. The spleen lies in the upper left part of the abdomen wedged in between the stomach, the diaphragm, and the left kidney, its greatest length lying roughly along the tenth rib. Thus, unless it is prolapsed and unduly mobile, the organ is not palpable unless it is considerably enlarged. The slighter degrees of enlargement, however, usually may be detected by means of percussion.

A splenic tumour due to enlargement of the spleen is usually characteristic; it projects downwards under the left costal margin, pointing towards the umbilicus, is smooth and firm, and closely in contact with the anterior abdominal wall. The characteristic notch usually can be felt on its anterior border, while the swelling is dull to percussion all over and moves freely on respiration. Such a swelling does not bulge out into the loin, and cannot be palpated bimanually with one hand behind as can a renal tumour. It occasionally increases in size after meals.

The spleen is almost completely surrounded by peritoneum, which passes from it on to the stomach and left kidney. The attachments which fix it in place are very indefinite, so that in many cases it becomes abnormally mobile. It is a very vascular organ, its arterial blood reaching it via the large and tortuous splenic artery, a branch of the cœliac axis, which passes behind the upper border of the pancreas and then traverses the lieno-renal ligament to reach the hilum of the spleen, which the vessel enters having given off the vasa brevia to the fundus of the stomach. The splenic vein, a large thin-walled vessel, joins the superior mesenteric behind the neck of the pancreas to form the portal vein. It has been shown that the blood from the splenic vein passes to the right lobe of the liver.

Little is known of the function of the spleen, save that it is concerned in some way in destroying worn-out red corpuscles, possibly in the formation of lymphocytes, and certainly that it is an organ where micro-organisms, etc., are removed from the blood in large numbers by the phagocytic action of the white cells congregated in nodules in the organ. Many other fanciful functions have been ascribed to it, such as that it acts as a reservoir of blood for the digestive system, or as a filter which removes organisms in the blood. No evil effects follow removal of the organ, though there may be some temporary alteration in the percentage of red cells and white cells in the blood, accompanied by enlargement of the lymphatic glands all over the body.

In certain diseases, an abnormal destruction of red cells and blood platelets occurs in the spleen, the removal of which effects a cure.

Injuries and Rupture of the Spleen. These are described in Chapter XIII., on p. 519. Their symptoms are chiefly those of internal hæmorrhage.

Splenic Abscess. Abscesses in the spleen are not very uncommon and are frequently the result of breaking down infarcts. Thus they occur in typhoid, pyæmia, endocarditis, or in association with injuries, where they are probably the result of the infection of a hæmatoma ; a suppurating hydatid cyst may be the cause. Such an abscess is liable to burst into the peritoneum, the pleura, the stomach or bowel, and may give rise to pylephlebitis. Occasionally it points and bursts externally in the loin.

The symptoms are vague ; rigors, high fever, and loss of weight occur, accompanied by pain and tenderness over the spleen, which may be felt to be enlarged. Frequently there will be signs of collapse of the base of the left lung, with pleurisy or even a peritoneal rub on respiration. In many cases the condition closely resembles a subphrenic abscess on the left side.

Treatment. If the condition is diagnosed the abscess must be opened and drained ; this is best done from the peritoneal aspect, the peritoneal cavity being packed off. In many cases large masses of necrosed splenic tissue will need removal.

Cysts and Tumours of the Spleen. These conditions are all rare. *Hydatid cysts* or *simple lymphatic serous cysts* are both seen ; *primary sarcoma, secondary sarcoma* and *carcinoma* both occur also. *Tuberculosis* of the spleen gives rise to an enlarged and hard organ. For all these conditions, except the secondary growths, the organ should be removed.

Floating Spleen. This is a not uncommon condition in which the spleen has an extra long pedicle and is free to move about the abdomen, where it has been found even in the right iliac fossa or the pelvis. In some instances torsion of the pedicle, with strangulation, has occurred, though the pedicle is occasionally found twisted without the blood supply being interfered with. It is usually seen in thin women who have borne many children ; but injuries or the presence of splenic enlargement undoubtedly predispose to it. The organ is usually enlarged and gives rise to a freely movable, rounded tumour, which swings about the abdomen on a pedicle in an arc of a circle which is concave upwards. It has the characteristic splenic shape, while the notch may be felt. The normal splenic dulness is absent, while vague pains and symptoms arise as the result of its dragging upon other organs, such as the stomach or duodenum. It has even pressed upon the pelvic organs, and been found in an inguinal hernia.

Treatment. Many cases are relieved by the use of a belt, accompanied by a long rest in bed and a diet calculated to fatten the abdominal wall.

Splenopexy is an operation which is often successful, and it should be performed provided the spleen is healthy and not very enlarged. The peritoneum is dissected up in the form of a pocket at the back and outer side of the abdomen over the twelfth rib, and a bed made for the organ there. The spleen is slipped through into this pocket and fixed there with stitches, while the peritoneum is snugly stitched around the splenic pedicle.

Another method of fixing the spleen is to expose the organ and pack gauze round it for four or five days to give rise to the formation of adhesions.

If the organ is diseased or enlarged, or if splenopexy fails, splenectomy should be performed.

Enlargement of the Spleen. This is a common condition and due to a great variety of causes. In many of these cases removal of the spleen is beneficial, but it is not so in all of them; while in some it is positively harmful. Most of the conditions giving rise to diffuse enlargement of the spleen are medical in nature, and reference must be made to books on general medicine and tropical diseases for a full description of them. In the subjoined list only the main points of those conditions likely to be benefited by splenectomy are indicated briefly. It should be understood clearly that this operation should never be performed in any of these conditions without careful investigation in collaboration with a physician and a pathologist.

(1) In many *blood diseases* enlargement of the spleen occurs; thus it is marked in *splenomedullary leucocythæmia* (leukæmia). It is very doubtful if splenectomy produces any benefit in this condition. At one time it was thought to be fatal, but recently it has been found that a preliminary application of radium produces an improvement, and after this splenectomy possibly may produce a further improvement.

In *splenic anæmia* (Banti's disease) an enlarged spleen occurs, accompanied in its later stages by a cirrhotic liver and a secondary anæmia which is often marked. There is a low colour index and a rather low platelet count, though rarely this may be normal or even increased; no leucocytosis is present. In the early stages of the cirrhosis this change can be shown to be confined to the right lobe of the liver, to which area, it has been shown, the splenic blood passes from the portal vein.

In the early stages of this disease marked improvement and even cure follows removal of the spleen, the anæmia subsequently disappearing; even in advanced cases splenectomy is followed by marked improvement in the blood condition and even lessening of the hepatic cirrhosis.

No splenectomy should be undertaken in cases with a high platelet count, as in several such cases death has occurred subsequently from portal thrombosis.

In *pernicious anæmia* enlargement of the spleen sometimes occurs; here splenectomy has a very high mortality and is of very doubtful benefit, though some improvements have been reported.

In all the above conditions, if a splenectomy is determined upon, its mortality will be lessened considerably if a preliminary blood transfusion is performed.

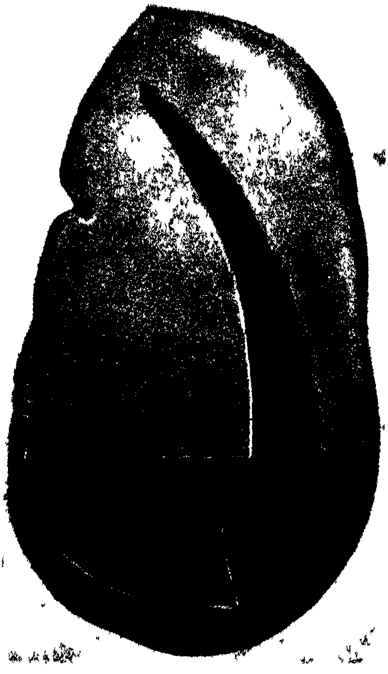


Fig. 267. Malarial enlargement of the spleen, showing the notch and uniform appearance of the splenic substance.

(2) *Chronic Purpura Simplex.* The spleen is seldom obviously enlarged in this condition, where there is often no other obvious blood change save

a low platelet count. Immediate and lasting relief from subsequent bleeding follows splenectomy, which should be performed in all cases where a diagnosis of purpura simplex is established.

(3) *Acholuric Jaundice.* This disease, which is sometimes known as congenital familial acholuric jaundice, or hæmolytic jaundice, is a rare condition which, when it occurs, is sometimes congenital and tends to run in families. There is jaundice, without bile in the urine and with normal-coloured stools, the condition being due to a very marked abnormal hæmolysis and being accompanied by severe secondary anæmia, while it is not uncommon to find attacks of pyrexia at intervals, which are accompanied by tenderness and further enlargement of the spleen. A very marked increased fragility of the blood corpuscles is often present. It is an odd thing that in many cases gall-stones are present, though there is quite definitely no obstruction of the bile-duct. This condition is usually cured rapidly by removal of the spleen, which always should be advocated.

(4) *Malaria* is one of the commonest causes of enlargement of the spleen. Such an enlarged spleen is known as the " ague cake," and is exceedingly fragile, adherent, and liable to rupture. In certain tropical countries a recognised form of assassination has been that of delivering a smart blow over the spleen, which will rupture the malarial organ almost universally present and lead to the death of the patient. A special instrument has even been provided by the Chinese for this pastime, known as a larang. Before removal of a malarial spleen, which is often advisable, all the ordinary methods of medical treatment must be tried.

Removal of a malarial spleen is urgently demanded if it is ruptured, and is justifiable if the enlargement is causing serious pain and discomfort. It may be a very difficult operation. Marked improvement follows splenectomy in those cases where severe anæmia is present with a large hard spleen.

(5) In *Egyptian splenomegaly* great improvement has followed splenectomy.

(6) *Gaucher's Splenomegaly.* Here the organ contains multiple rounded granulomatous masses which may be sarcomatous as they also occur in the liver, and sometimes all over the body in the skin and subcutaneous tissues. There is great enlargement of the liver and spleen and marked ascites. The cases do well after splenectomy.

(7) In *injuries of the spleen*, *tumours*, *cysts*, *abscesses*, and a few cases of *splenomegaly* of unknown origin the operation is generally required.

Splenectomy should NEVER be performed in certain diseases :

(1) *Hodgkin's Disease* (see Vol. I., Ch. XI.). Here enlargement of the spleen occurs in association with lymphadenomatous deposits elsewhere all over the body. Splenectomy is absolutely contraindicated.

(2) In *kala-azar ;* here the spleen is enlarged, and splenic puncture to withdraw blood to establish the diagnosis is often performed. Splenectomy should not be performed.

(3) There are many *general diseases*, such as congenital syphilis, typhoid, amyloid disease, rickets, general tuberculosis, cirrhosis of the liver, and cases where there is marked back pressure from the heart due to valvular disease or disease of the lungs, where enlargement of the spleen occurs. In all these conditions, of course, splenectomy is absolutely contraindicated.

SPLENECTOMY

Though many incisions have been advocated for this operation, such as one parallel to the left costal margin, a transverse incision, and a T-shaped incision, in nearly every case it can be comfortably done, if the patient is sufficiently relaxed, through a long vertical incision, either splitting or drawing aside the left rectus muscle. Incisions in which the costal margin is resected are hardly ever required. The spleen having been identified, it must be examined carefully to see if adhesions are present. If there are none and there seldom are, the operation may be easy. Occasionally, however, these are present, especially if previous X-ray therapy has been applied, and then the operation may be one of the most difficult in surgery, or even impossible. It must be remembered that the spleen is very easily torn, often being softer than the adhesions in its neighbourhood, and fatal hæmorrhage is easily caused. The lower part of the gastro-splenic omentum having been divided between ligatures, the organ is gently drawn up to the wound and the outer layer of the lieno-renal ligament carefully divided with a knife; hæmorrhage seldom occurs save rarely at the upper end of the ligament. (There is reason to think failure to perform this step is the reason why some surgeons meet with such frequent adhesions.) The spleen now can be brought to the surface easily, the pancreatic tail identified and isolated, and the splenic vessels ligatured and severed. Care should be taken to divide the artery first and allow a few minutes for the blood to drain from the organ, which should *not* be squeezed, before severing the vein.

After this operation hæmatemesis sometimes occurs, but this is almost certainly due to damage to the veins of the vasa brevia, which causes congestion of the stomach. In other cases an inexplicable pyrexia is seen for some days ; this is possibly due to damage to the tail of the pancreas, permitting the escape of pancreatic fluid, and care should be taken that this damage does not occur when dealing with the splenic pedicle. Septic infection of the pedicle is not uncommon.

CHAPTER XIX

INJURIES AND DISEASES OF THE RECTUM, ANUS AND ISCHIORECTAL FOSSÆ

Surgical Anatomy. Surgically, the rectum may be said to extend from the pelvirectal junction, situated in front of the sacral promontory, to the exit of the anal canal on the surface between the nates. Anatomically and developmentally, however, this length of the intestinal canal comprises two separate entities :—

(*a*) *The rectum proper*, developed from the hinder end of the midgut, and endodermal in origin, which extends from the pelvirectal juncture to the upper end of the narrow anal canal. The rectum is 5 or 6 inches long, and lined with thick columnar-celled epithelium, in which are numerous tubular mucous glands; this mucous membrane is thrown into transverse folds, of which three, usually one on the right and two on the left at a lower and higher level, are especially prominent, and form the *valves of Houston*, which may interfere with the passage of the proctoscope.

(*b*) *The anal canal*, developed from the epidermal invagination of the cloaca (proctodeum), and originally separated from the rectum by a membrane, which disappears about the fourth month of intrauterine life; the edges of this can be seen in the adult at the ano-rectal junction as the thin *white line of Hilton*. The anal canal is smooth and lined with stratified epithelium, while around the anal margin the skin is thrown up in radiating rugæ; at the upper end are seen a series of thickened longitudinal processes, the *columns of Morgagni*, between which lie the pitlike sinuses and *valves of Morgagni*, which may be torn away or lodge foreign bodies and serve as a starting point for perianal infections.

The *musculature*. The walls of the rectum and anus consist of longitudinal and circular fibres homogeneously distributed, and fusing just above the ano-rectal junction with the levatores ani and internal sphincter muscles, which together with the thick ringlike external sphincter ani surrounding the anal canal establish a certain amount of voluntary control over evacuation of the lower bowel. The *nerve supply* of the muscles is derived from the sympathetic, except the external sphincter and levatores ani, which get their supply from the pudic nerve.

The *arterial supply* of the upper part of the rectum and rectal mucosa is derived from the superior hæmorrhoidal, a direct downward continuation of the inferior mesenteric artery, while that of the anal canal, lower part of the rectum, and ischiorectal fossæ is from the inferior hæmorrhoidal branch of the internal iliac artery. Around and in the wall of the lower part of the rectum free anastomosis occurs between the superior and inferior hæmorrhoidals, and to a lesser extent with the middle hæmorrhoidal which, however, is mainly exhausted in supplying the perirectal cellular tissue.

The *venous return* is important, as the superior hæmorrhoidal vein, draining the rectal wall and mucosa, passes into the valveless portal circulation, while the inferior hæmorrhoidal drains the anal canal across the ischiorectal fossæ to the systemic circulation. The radicles of these two veins inosculate freely in the submucous tissue of the lower end of the rectum, and any obstruction to the venous outflow of the portal circulation is reflected to this dependent area, where the distended veins bulging into the rectal lumen constitute hæmorrhoids, and earn for this area of the mucosa the title of the " pile-bearing area."

The *lymphatic drainage* of the rectum runs around the gut, and thence into the numerous nodes lying in the cellular tissue behind and beside the bowel in the concave sacral bend of the pelvis, whence the lymph drains up via the lower part of the sigmoid mesocolon into the aortic lymph nodes.

The anal canal, perineum and ischiorectal fossa, and to some extent the lower two inches of the rectum, drain into the inner group of the horizontal inguinal nodes (Vol. I., Ch. V.); when inflamed these may be mistaken not infrequently for a strangulated or irreducible femoral hernia (Chapter XIV., p. 598) if the anal or rectal infection be overlooked.

Examination of the anal canal and rectum never should be omitted in any case of abdominal injury or disease, and may be conducted either digitally or visually with the aid of the proctoscope or sigmoidoscope.

(*a*) *Digital examination* is conducted with the index, or index and middle fingers, which should be encased on every occasion in a rubber glove, which must be greased to facilitate the passage of the digit into the rectum. The best position is to have the patient standing and instruct him to squat on the examining finger, when, as he strains down, the lower 5 or 6 inches of the bowel may be explored; it is more usual to examine in the genupectoral or lateral prone position, but in these attitudes only 3 or 4 inches of the bowel can be reached by the examining finger.

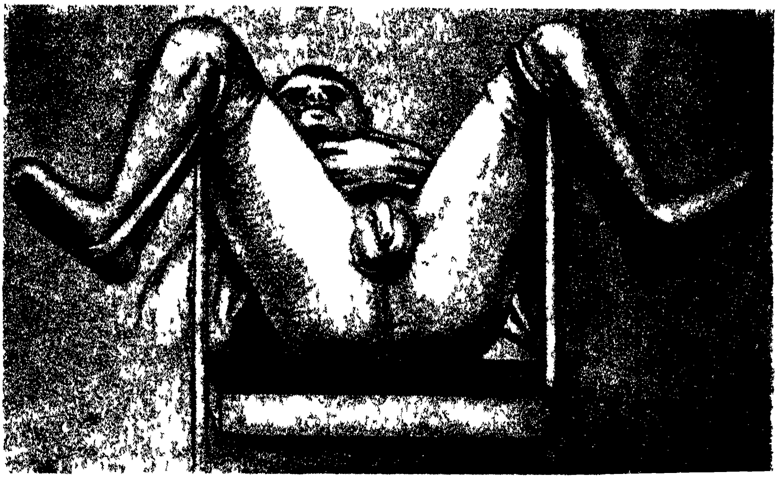
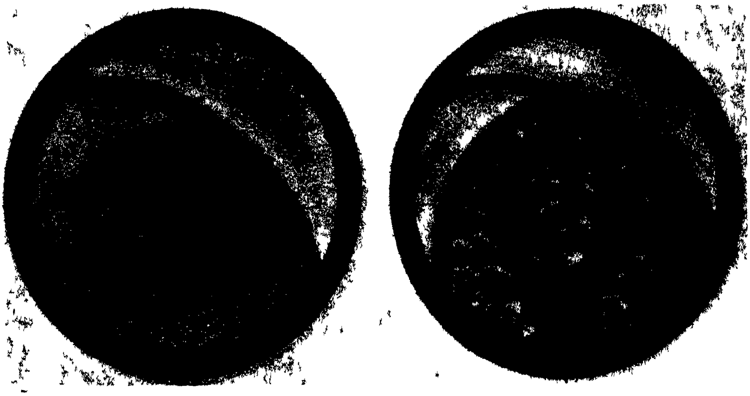


FIG. 268. Patient in the lithotomy position.

In examining the rectum digitally note any spasm of the sphincter, and in the male the feel and consistence of the prostate, on which the finger impinges anteriorly, and the vesiculæ seminales above this; also if the mucosa is movable over them. In the female the cervix uteri forms a rounded prominence, felt moving through the rectal wall, and if a pessary is worn in the vagina this also will be detected. The rectum should feel moist and warm to the examining digit, and the mucosa smooth and velvety; any abnormal hardness or irregularity in the lumen or around the



A. B.

FIG. 269. Sigmoidoscopic appearances in the rectum. A. Normal rectum. B. Carcinoma of the rectum.

bowel wall should be noted. The condition of the perineum, perianal skin, and ischiorectal fossæ should be observed.

(*b*) *Visual Examination.* A greased *proctoscope* or *sigmoidoscope* is carefully introduced through the anal canal, with or without an anæsthetic, and the inner aspect of the bowel examined by direct vision, light being provided by an electric lamp in the lumen of the tube-like instrument.

The sigmoidoscope, which consists of a long tube about one and a half inches in diameter, is stopped with an obturator and gently introduced through the anus. The patient may be in the lithotomy or left lateral prone position; where the instrument is introduced under local anæsthesia, the genupectoral position is to be preferred, as the bowel can then be "threaded" over the instrument by manipulation through the abdominal wall.

So soon as the sigmoidoscope is introduced the obturator is withdrawn, the light inserted, and the instrument passed gradually up under direct observation. Much assistance may be afforded by judicious inflation of the bowel with air, but the pump must be under control of the surgeon. Some difficulty may be experienced in passing the pelvirectal junction, but if the instrument is gently manipulated by depressing the handle to the right and backwards, the front end will be guided forwards and to the left around the sacral promontory into the colon.

By this means tumours, ulcers, etc., can be detected readily and if the bowel be clear, a view obtained up to the splenic flexure, which appears as a slit running antero-posteriorly in the bowel. The colon and rectum should be examined carefully again on withdrawing the sigmoidoscope. Should the bowel wall by accident be perforated by the instrument, an immediate laparotomy must be performed and the rent sutured, when no untoward results usually accrue from the mishap.

CONGENITAL MALFORMATIONS

Persistence of the hind gut (neurenteric canal) is infrequent and always incomplete, solid tumours (chordoma) or cysts being found behind the rectum and anterior to the vertebral bodies. Such cysts are tubulo-dermoids (Vol. I., Ch. VIII.) in type. *Sacrococcygeal sinuses* met with in this region are usually due to breaking down of such cysts following infection. These sinuses are lined with epithelium and call for extensive dissection to ensure their complete removal.

Persistence of the cloacal membrane (primitive streak) is far more frequent and gives rise to **imperforate anus** in its common form, where only a thin membrane prevents the escape of meconium; this bulges the membrane through the anal canal as a plum-coloured mass, more obvious when the child strains and cries.

Absence of development of the rectum is not common, but again gives rise to imperforate anus, the anal canal being present and admitting the finger, which passes into a cul-de-sac. On exploration the distended colon may be felt and found at the pelvic brim.

Failure of formation of the proctodeal invagination is the third cause of imperforate anus, a small pigmented area being present on the perineal raphé, which is usually bulged outwards by the distended rectum behind.

Failure of development of the longitudinal septum, which grows down in the second month of intrauterine life, and normally separates the genitourinary canals from the rectum and anus, will permit of the bowel opening into the bladder, urethra or vagina. This deformity is often present with imperforate anus.

Clinically, imperforate anus, if undetected, will give rise to signs of intestinal obstruction after some days. No meconium is passed, and examination will reveal an absence of the anus (in which case a perineal bulge is usually present, more obvious when the child cries) or the presence of an anal cul-de-sac not connected with the rectum. Other deformities may coexist, the commonest of which in female children is a rectovaginal fistula, through which liquid fæces will be passed, the baby being incontinent. Partial occlusion of the anal canal may be present.

Treatment. The imperforate anus must be dealt with promptly by dividing the thin, bulging cloacal membrane, if this be the cause. In other cases an incision must be made through the perineal raphé in the position of the anus; the cellular tissue is gently explored, care being taken not to damage the ureters, and the lower end of the rectum or colon located, drawn down to the anus, opened and sutured to the skin edge. If the bowel cannot be brought down a colostomy should be performed, and many surgeons prefer this method in all cases, as the child is usually incontinent, except when only a membranous septum is present.

In cases of communication with the genital and urinary canals a colostomy should be undertaken, and in some cases the communication can be closed subsequently, but no operation is advisable for three or six months unless obstruction occurs.

Dermoid cysts can be detected as rounded masses outside the bowel and seldom give rise to symptoms till adult life, when they may obstruct labour in the female. Rarely a ventral meningocele in the lower lumbar or sacral region may give rise to errors in diagnosis. Infection and suppuration rarely occur.

The *treatment* consists in excision only if symptoms occur.

INJURIES OF THE RECTUM AND ANUS

These have already been discussed (Chapter XIII., p. 526), but it cannot be impressed too strongly on the reader that any wound of the buttocks and perineum is very liable to damage the rectum, which in all such cases should be examined carefully digitally and, if possible, visually through a proctoscope. Foreign bodies introduced through the anus also may cause perforation of the bowel, which usually takes the form of a rent opening into the perirectal cellular tissue; but if the body is sufficiently long to reach the region of the pelvirectal junction, it may penetrate into the peritoneal cavity. In the male the bladder and urethra are very liable to be damaged at the same time.

As already stated, there may be great initial shock, but often nothing suggests damage to the bowel until pelvic cellulitis or peritonitis supervene.

Treatment consists in suture with, if necessary, laparotomy and colostomy.

The anus may be lacerated, and occasionally the external sphincter muscle ruptured, by over-stretching in the rough introduction of surgical instruments or foreign bodies.

Treatment consists in hot bathing and the application of unguents; the incontinence consequent on muscle rupture is usually of a temporary nature. Should suppuration occur, the inner inguinal nodes will be enlarged and tender, and as there is constipation due to pain on defæcation they may be mistaken for a strangulated femoral hernia unless the perineum be examined.

Foreign Bodies. Three sorts of foreign bodies may be met with in the rectum:—

(*a*) Swallowed bodies, such as tooth plates, coins and bones. which usually catch up in the valves of Morgagni and may start a fissure-in-ano (p. 782) or a perirectal abscess (p. 786).

(*b*) Introduced bodies passed up through the anus, which may vary in size from a pea to a soda-water bottle, even including a bust of Napoleon.

(*c*) Bodies formed in the intestinal tract, such as gall-stones and intestinal sand.

Clinically, the presence of a foreign body is indicated by pain and tenesmus, and if it has been present some time a purulent discharge may be seen or blood may be passed. Sharp bodies tend to penetrate the rectal wall, when infection, with consequent perirectal abscess, often results.

Digital, visual, and X-ray examination should be conducted and the body located and removed through the anus, if possible or if not, by laparotomy. In the case of large bodies anæsthesia is required, but the anal canal can be stretched under 4 per cent. cocaine ointment.

INFLAMMATION OF THE RECTUM

The rectum, like the colon, is very liable to infection from the stasis of intestinal contents, and *proctitis* is therefore more likely to be met with in constipated subjects, when, owing to slight trauma from the passage of scybalæ, periproctitis often may be associated with the inflammation of the rectal mucosa, and ulceration is not infrequently present.

Catarrhal or mucous proctitis is often associated with a like condition in the colon and is characterised by a feeling of tenesmus, with a glairy white discharge which usually dries around the anus and is a fruitful source of pruritus.

The condition is seen in chronic constipation, mucous colitis, the presence of foreign bodies or scybala in the rectum, hæmorrhoids, worms in the lower bowel, and last and most important, in association with neoplsams of the bowel, of which carcinoma is the most common.

If the mucus excreted is excessive there may be a continuous pseudo-diarrhœa, which is most marked when the patient is up and about, and usually causes an immediate desire for the closet so soon as the upright position is assumed on getting up in the morning (morning diarrhœa).

Treatment consists in discovering the cause and treating this, when the secondary proctitis will subside. Tumours need excision, scybala and foreign bodies removal by suitable means. Cases due to coexisting mucous colitis (Chapter XVI., p. 661) are very intractable, but if the ætiological bacteria can be discovered, vaccines may yield good results, especially in those cases due to B. mucosus capsulatus.

Irrigation with normal saline, 1 per cent. silver nitrate solution or boric lotion may be a useful adjunct to the foregoing treatment. Drastic purgation should be avoided.

Purulent proctitis is characterised by great rectal pain, tenesmus, constipation, and purulent discharge which dries round the anus, and makes this excoriated, sore and itching. Inguinal adenitis often occurs, as also periproctitis and abscess formation in the ischiorectal fossæ.

(*a*) The disease may be an advanced stage of catarrhal proctitis, and due to similar causes which have been persistently neglected, and in these cases treatment on the lines indicated will effect a cure.

(*b*) **Gonorrhœal proctitis** is by no means uncommon in women as a result of infection from the vulva, and in young men as a result of sexual malpraxis. There is a mucoid discharge for a few days after infection, with a tendency to diarrhœa and a feeling as if rough sand is present in the bowel. In two or three days the discharge becomes copious and purulent, with a development of inguinal adenitis and aggravation of all local symptoms. Severe tenesmus, with frequent attempts at stool, are characteristic, and in severe cases blood may be passed and the inflamed mucosa prolapsed. The perianal skin is fissured, œdematous and tender. Rectal examination is very painful and must be made with a gloved finger; the mucosa is œdematous and tender, and on visual examination is seen to be red, velvety, and secreting mucopus or frank pus from the crypts. Later, ulceration and subsequent stricture, from fibrosis, are frequent sequelæ of the inflammation.

Treatment. Hot hip baths and rectal irrigations give great relief, and in addition the bowel should be swabbed with 3 per cent. silver nitrate solution and gonococcal vaccine administered while sulphanilamides are taken by mouth. Needless to remark the patient should be isolated and all bedpans, instruments, linen, etc., carefully sterilised after use and marked. Gentle aperients, such as Cascara sagrada, grs. iii, or Conf. senna, ʒii, should be given regularly.

(*c*) **Dysenteric proctitis** may occur after (1) *bacillary dysentery*, when the organisms can be recovered from the thick mucopurulent discharge; the bowel is much ulcerated, and often tunnels of granulation tissue occur under apparently intact mucosa. The condition yields to antisera and irrigation, but rectal stricture and hæmorrhoids are liable to persist.

(2) *Amœbic Dysentery.* Here the condition is more severe, with a thin seropurulent discharge, among which shreds of mucosa and amœbæ can be found. The mucosa is much ulcerated and œdematous, with extensive tunnelling; this involves the rectal wall, which becomes thickened and contracted to a lumen like a pipe-stem. In both varieties the colon is extensively involved also.

Treatment consists in daily injections of emetin and lavage of the bowel with 1 per cent. quinine sulphate solution, but the prognosis is grave; those cases where the mucosa is destroyed and the bowel contracted are always fatal, and present signs very like those seen in tuberculous peritonitis (Chapter XIII., p. 550).

(*d*) **Gummatous proctitis** is rarely seen but may cause a purulent discharge, examination showing the whole rectum to be œdematous, with numerous small, round, punched-out ulcers. Strictures frequently follow.

(*e*) **Tuberculous proctitis** is more common and always occurs in patients with pulmonary or intestinal tuberculosis, the bacilli being deposited on the lower end of the rectal wall, and there causing ulceration with consequent fistula formation.

(*f*) **Bilharzial proctitis** is common in Egypt, South Africa and Mesopotamia, and may be associated with bladder lesions. There is free rectal bleeding, and sometimes a mass of granulations protrudes from the anus, but in any case the rectal mucosa feels soft and spongy, the finger sinking into it, and on visual examination it resembles a red pile carpet; the typical spiked ova can be isolated from these granulations. The condition is common in children, and usually causes severe anæmia, but tends to gradual spontaneous cure if the patient is removed from the infected area. Antimony salts should be administered intravenously (Vol. I., Ch. VI.).

(*g*) **Yaws** also affects the rectum and anus, producing a somewhat similar appearance and yielding readily to injection of neosalvarsan.

Both these conditions are often followed by stricture of the rectum.

(*h*) **Threadworms** (Oxyuris vermicularis) are a common cause of proctitis and pruritis ani in children and should be treated by irrigation of the rectum with salt or quassia solution, and the administration of calomel, gr. i, and santonin, grs. iii, for three successive nights.

ULCERATION OF THE RECTUM

This results from localised or generalised destruction of the rectal mucosa in any of these infections, and the characteristics seen elsewhere in the body are often masked by secondary infection from the fæces. The commoner ulcers seen on proctoscopy are briefly described below.

(1) *Simple ulcers* result from the pressure of foreign bodies or scybala and are sometimes called fæcal ulcers. Such ulcers are usually small and circular in shape and may be multiple ; the mucosa around may be somewhat œdematous, but is otherwise healthy. The ulceration is usually at the lower end of the rectum or in the anal canal ; there is a mucosanious discharge and pain on defæcation.

Fissure-in-ano is an example of simple ulceration following trauma, a hard scybalous mass usually catching in one of the valves of Morgagni, which is torn away, pulling with it a strip of anal mucosa, which rolls up and lies at the lower end of the fissure as an œdematous mass, the so-called " sentinel pile " of Ball (Fig. 271). The fissure is usually situated posteriorly and may escape notice unless the œdematous mucosa is retracted gently, when the smooth surface of the ulcer, usually broader above, will be detected, though the spasm of the sphincter ani may further mask it. There is a characteristic and great spasm of the sphincter ani, and the patient much resents attempts at examination because of the pain caused. For the same reason there is often constipation, every effort being made to avoid defæcation, which is succeeded by an intense burning, sickening pain of from a few minutes to several hours' duration.

The condition is rare in children, but when present often causes reflex retention of urine. The motions are usually narrow and ribbon-like, owing to the reflex spasm of the external sphincter, and may be streaked with blood in the region of the fissure.

Treatment is simple and consists in over-stretching and so temporarily paralysing the external sphincter, care being taken not to rupture its fibres, an operation which yields very excellent results. Some surgeons prefer to curette the ulcer or excise the area and suture the raw surfaces, but these give no better results than the more simple procedure, except in old-standing and neglected cases where considerable fibrosis is present. When piles or fistula-in-ano coexist these need appropriate treatment. In early and mild cases the injection of a heavy oil basis containing a local anæsthetic (such as A.B.A.), by producing temporary paralysis of the sphincter, may effect a cure, but in our experience recurrence of the fissure occurs not infrequently unless the sphincter is stretched also.

As might be expected in any condition of ulceration of the mucous membrane, secondary infection of the perirectal cellular tissues and glands, often with abscess formation, are fairly common complications.

(2) **Dysenteric ulceration** is characterised by numerous minute ulcers distributed throughout the rectum (and colon), the mucosa appearing generally thickened and œdematous, and often being tunnelled under its apparently normal surface with granulating tracks. Later there is a coalescence of these ulcers with resultant formation of a large oval area, which appears smooth and shiny from the fibrous tissue in its floor ; in still later cases the whole bowel is much thickened and contracted down, so that the lumen may be little larger than a pipe-stem and entirely denuded of mucous membrane.

(3) **Tuberculous ulceration,** as already stated, occurs in patients with pulmonary or intestinal tuberculosis, the ulceration usually occurring in the lower rectum or anal canal and often starting in the valves of Morgagni. Miliary tubercles can be seen in the thickened mucosa around the ulcer as greyish spots, and the ulcer itself is usually superficial, with œdematous overhung edges, oval in shape, and with rather abundant pale granulations on the floor. In one type, usually in the anal canal, the induration and nodulation around the ulcerated area assume great proportions, and this hyperplastic form may be mistaken for carcinoma, the more so as it is frequent in adults.

Penetration of the deeper coats of the bowel and involvement of lymph nodes is the rule, so that ischiorectal abscess with subsequent fistula-in-ano is by no means uncommon (p. 787); this can be diagnosed on a microscopic section being made of the wall of the fistula when giant-celled systems are visible.

(4) **Syphilitic ulceration** of the rectum may occur at any stage of the disease.

(*a*) The *primary sore* is seen in the lower rectum or anal canal in women and youths as the result of sexual malpraxis, as a painless, indurated ulcer, with painless, discrete, mobile glands at the inner end of the inguinal group. The ulcer is usually situated at or within an inch or two of the anal orifice, and there is considerable surrounding induration.

(*b*) *Secondary syphilis* may cause "snail track" ulceration of the rectum and anus, when the typical creeping, shiny, superficial erosions will be present. More often **condylomata** occur and present as a protruding mass of œdematous granulations covered with sodden epithelium and accompanied by a thin and often sanious discharge. In women they often extend forward around the vaginal orifice, but in either sex, if confined to the anal margin, they are often on a superficial examination diagnosed as hæmorrhoids.

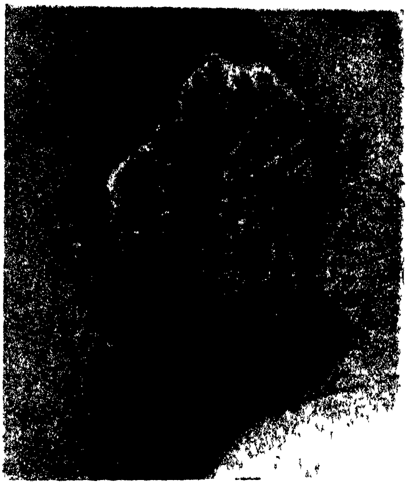


FIG. 270. Condylomata at the anus with the scar of a primary sore below.

(*c*) *Tertiary or gummatous lesions* may be localised, when a typical circular, punched-out ulcer will be seen; or diffuse, when the whole rectal wall is infiltrated, the mucosa œdematous, and many small circular ulcers will be present. This diffuse form is succeeded by dense fibrosis and stricture of the rectum; perirectal infection with formation of numerous fistulæ and scarring is frequent. In women rectovaginal fistula may occur.

The *diagnosis* is usually easy as there are lesions elsewhere, and except in the primary stage the Wassermann will be positive. Condylomata should be treated with washes and iodoform powder dusted on; no operation should ever be undertaken for their removal. General antisyphilitic treatment should be instituted.

(5) **Bilharziosis** produces ulceration, though this is masked by the masses

of spongy, bleeding granulation tissue thrown out which, in slight cases, give the rectum a typical velvety appearance; in severe cases they cause protrusion of masses of granulations, which may be mistaken for hæmorrhoids. Bleeding is severe and intractable, and fistula formation common.

(6) **Malignant ulceration** occurs in carcinoma, and the neoplasm can be detected on examination.

Clinically the signs produced are very similar in all cases of ulceration of rectum, there being tenesmus and rectal discharge, with pain which varies in severity according to whether the ulcer is high in the rectum, when it may be absent, or in the canal, when it is severe and persistent after defæcation. As already stated, the accumulation of mucus in the bowel overnight causes the patient to run to the closet to defæcate immediately on rising in the morning, while "spurious" diarrhœa will occur in the day, flatus, mucus and small amounts of blood being voided. The condition is uncommon in children and young adults, and, on the whole, more often met with in women.

"It must be understood that such symptoms in any patient over thirty-five should be regarded as probably due to malignant ulceration, and a thorough examination of the rectum must be carried out in all cases."

Treatment should be directed to the cause of the ulceration and the bowels regulated by some laxative such as Conf. senna, ʒi, or Cascara sagrada, grs. iii, o.n.

Relief of local tenesmus follows hot baths, and, except in the case of an anal fissure, warm rectal irrigation is very comforting, besides tending to cleanse the ulcerated surface.

Periproctitis or inflammation of the cellular tissue around the rectum is due nearly always to secondary pyogenic infection in ulcerative proctitis, which may be a direct invasion or be lymph-borne. A similar condition follows wounds of the rectum. Suppuration is common, and the various forms of perirectal, perianal and ischiorectal abscess result, with formation of persistent fistulæ in many cases.

Rectal and anal strictures result in many cases from the cicatricial contraction subsequent to any of the foregoing inflammatory lesions, being particularly liable to occur in dysenteric, gonococcal, lympho-granulomatosis and diffuse gummatous lesions. Anal stricture is also seen in cases where an operation for hæmorrhoids has been too thoroughly performed or been followed by breaking down of the mucous membrane (p. 794), and is deliberately aimed at in cases of rectal prolapse. Miles and others have described a spasmodic stricture of the anal sphincter, usually seen in elderly men, which, if neglected, gives rise to fibrosis just above the external sphincter ani with the formation of a ring of fibrous tissue (*pecten band*) in the sub-mucous tissues, possibly as a result of ischæmia and infection. Carcinoma, of the "ring" variety, will produce a fibrous stricture, and the vast majority of cases are due to this cause, though dysentery runs a close second.

The stricture may be linear, tubular or annular, according to its cause and extent, malignant strictures being usually annular and dysenteric tubular in type. The appearance of the bowel in a specimen is characteristic, the part above the stricture being thickened and distended, and often showing small ulcers in the mucosa, while that below is dilated, thinned and paralytic owing to the involvement of nerves and vessels in the fibrosed bowel wall; it is usually described as "ballooned." If low down, paralysis of the sphincters with incontinence will result, while owing to impeded venous return hæmorrhoids are usually present.

Clinically there are signs of intestinal obstruction, which may be slight or complete. Usually periods of obstinate constipation alternate with spurious diarrhœa. The patient is generally wasted, with an earthy complexion and a rather red nose, the tongue dirty and the breath foul. Occasionally there may be vomiting, usually only when acute obstruction supervenes. The abdomen is often distended and much flatus passed.

Hæmorrhoids or rectal discharge from the ulceration are often present.

On digital examination the rectum may be felt ballooned or the stricture palpable, and this can be detected on proctoscopic examination.

Treatment is never very satisfactory, and in most cases inguinal colostomy gives the best results, and this in the case of the single simple stricture may be succeeded by perineal excision of the rectum. In malignant disease the bowel and tumour may be removed in suitable cases (p. 804). In simple stricture the cause should be treated and attempts made to dilate the stricture by the passage of graduated gum-elastic rectal bougies. If successful, this method should be carried on regularly at frequent intervals, and the patient may be given a bougie to pass daily. In venereal strictures improvement is recorded following oral administration of sulphanilamide.

Proctotomy for the division of the stricture may be a necessary preliminary to this bougie treatment, and may be carried out from within by a series of linear incisions carried through the stricture (*internal proctotomy*) ; or the external method, where the bowel is exposed from behind, by removal of the coccyx and the incision carried from without inwards through its wall, may be employed. Either is liable to be followed by perirectal suppuration. In those cases where a definite pecten band is present, some relief follows its division, but careful after-treatment and regular anal dilatation are necessary. In the early stages relief follows the administration of a mixture containing

℞ Sod. Bicarb. . . . . . . ʒi
Tinct. Belladonnæ . . . . . ♏vi
Aq. Chloroformi . . . . ad ℥ss. t.d.s.

In any case the bowels must be kept regularly opened, and in stricture cases Liq. paraffin, ʒii—℥i, t.d.s. is by far the best aperient, as it not only liquefies but also lubricates the fæcal residue.

SUPPURATION AROUND THE RECTUM AND ANUS

Suppuration in the cellular tissue and lymph nodes around the rectum and anus is a frequent sequel of any of the foregoing infections of the bowel, and also after inflammation of hæmorrhoids, or of the skin of the perineum. The infection usually localises with abscess formation, but occasionally there is a generalised cellulitis, and in women this occurs secondary to pelvic cellulitis from uterine infections (Chapter XXII., p. 968). The infection is usually mixed, B. coli, staphylococci, and, occasionally, streptococci, being present; more rarely, gas-forming organisms are met with. Tubercle bacilli are also met with, but rarely in pure culture.

According to the seat of the infection the abscess will be situated above the levator ani muscle (*pelvirectal abscess*), or below it (*ischiorectal and perianal abscess*), while according to the causative organism its onset will be acute or gradual, often the latter ; the abscess is usually situated outside the bowel, but may be in the submucous tissue (*submucous abscess*), and, if unopened, will tend to point along the line of least resistance. Owing to the constant movement of the muscles in the region and the devious route pursued by the pus tracking around muscle attachments, the tortuous track tends to provide inadequate drainage, rest is insufficient, and infection from the bowel continues, with the result that healing is long delayed and sinus and fistula (p. 787) are frequent sequelæ.

Clinically, there is a sense of fulness and discomfort around the anus, which may be acute or scarcely noticeable at first. Later a swelling develops beside the anus in ischiorectal abscesses and can be detected on rectal examination in pelvirectal suppuration. This is at first boggy, and later definitely fluctuates. Constipation is usually present and may be relieved by the use of laxatives.

The *treatment* consists in prompt incision as soon as the condition is diagnosed. This must be done under anæsthesia and the incision freely made, but at the same time avoiding damage to the sphincters and levator ani, especially the insertion of the latter into the lower rectal wall, or incontinence will ensue. Hot baths or rectal lavage may be carried out regularly, and if this line of treatment be pursued there is little chance of fistula resulting. Should hæmorrhoids coexist, which is often the case, these should be dealt with subsequently. Packing and plugging is, as a rule, unnecessary and causes great discomfort to the patient. The patient should be kept at rest in bed for at least fourteen days.

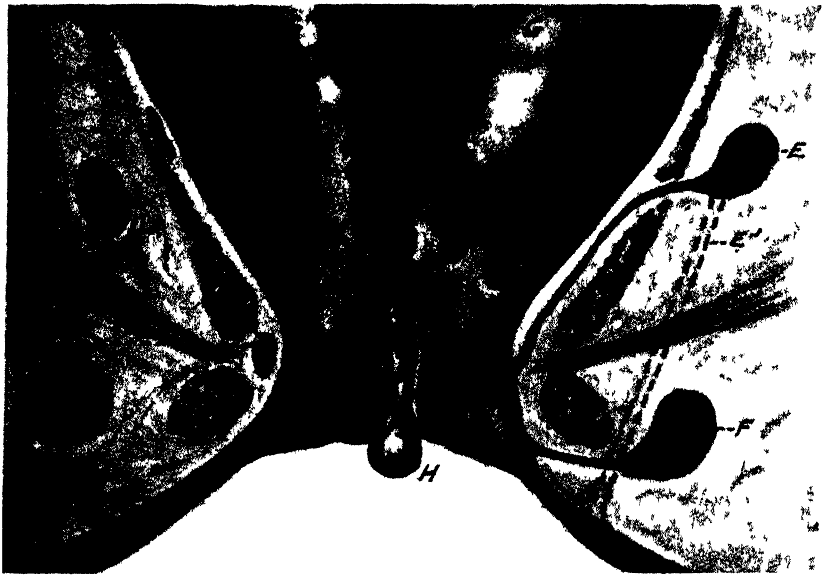


FIG. 271. The lower end of the rectum and the anal canal laid open from the front, showing:—*A*, ischiorectal abscess and *F*, sinus resulting from the same; *B*, *D*, submucous abscesses; *C*, pelvirectal abscess, with resulting fistula *E*, submucous and E^1, rare trans-levator ani route; *G* and G^1, hæmorrhoids; *H*, fissure-in-ano with "sentinel pile."

Varieties of Abscess. (1) **Perianal abscess** is more common in males and follows infection of the skin, usually from the friction of dirty clothes. The resulting lesion is similar to any other boil and calls for no special comment except that rest in bed for at least ten days is essential if the risk of sinus formation is to be avoided. The pus may lie occasionally between the anal mucosa and the external sphincter, when it usually points at the mucocutaneous junction.

(2) **Ischiorectal abscess** arises in the lymph nodes in the ischiorectal fossa following infection around the sinuses of Morgagni, and is thus the commonest form of perirectal abscess. Not infrequently it may be primarily tuberculous, when it presents as an induration of some standing beside the anus, but secondary infection sooner or later occurs and then an acute abscess develops. In the acute stage there is severe pain on defæcation or attempting to sit down, and a brawny, red, fluctuating mass presents beside the anus. If unopened the pus usually points backwards and crosses the coccygeus muscle to burrow into the ischiorectal fossa on the opposite side, giving rise to a horseshoe fistula (p. 788). Walking becomes painful and retention of urine may occur. The abscess is commonest in adult males, and frequently follows infection of existing hæmorrhoids, which need subsequent removal.

Treatment consists in early and free incision, which may be made crucial or T-shaped to promote easy escape of pus. Hot baths should be given twice daily and a dry dressing worn between these. Plugging should be avoided, as it tends to bottle up pus. The patient should be kept at rest in bed for at least fourteen days, and the bowels kept open with gentle laxatives, such as Conf. Sennæ, ʒi, o.n., or Liq. Paraffin, ℥i, o.n. Hæmorrhoids should be operated on about a month or six weeks after the abscess has healed.

(3) **Submucous rectal abscess** is not common and presents as a longitudinal bulging swelling, detected on rectal examination. There is some pain and discomfort and occasionally tenesmus. If neglected a sinus results, and troublesome rectal discharge and pruritus ani are liable to set in. The abscess should be freely opened through a speculum by a longitudinal incision, and the rectum washed out regularly with warm saline. Rest in bed is advisable.

(4) **Pelvirectal abscess** lies above the levator ani in the cellular tissue between that muscle and the upper part of the rectum, and usually occurs in the course of a general pelvic cellulitis, either from uterine infections in parturient women or following appendicitis in children; more rarely it may result from dysenteric proctitis or carcinoma of the rectum, and more rarely still from tuberculous osteitis of the pelvis, usually secondary to disease of the hip joint.

The pus usually bursts into the bowel above the levator ani, but occasionally may penetrate the muscle and point in the ischiorectal fossa.

Clinically, the signs and discomfort of the pelvic cellulitis mask the rectal signs until the pus bursts into the bowel and is evacuated per anum, but occasionally there may be a discharge of mucus and tenesmus, which contrasts strongly with the obstinate constipation usually met with in pelvic cellulitis.

The *treatment* consists in freely opening the abscess into the bowel *above* the insertion of the levator ani, which must on no account be divided or else incontinence will ensue permanently. This operation must be carried out through a proctoscope, and the incision enlarged so that free escape of pus is ensured. Plugging can then be avoided to the patient's comfort, and regular rectal irrigations instituted twice daily.

The patient needs to be kept in bed for fourteen to twenty-one days to ensure healing and avoid the risk of a fistula, which is a serious complication not likely to occur if free and early incision is carried out.

FISTULA-IN-ANO

Fistula-in-ano is the result, as already stated, of the inadequate drainage which occurs when perirectal and perianal abscesses are not promptly and freely opened, as the tortuous track around muscle attachments, by which the pus points naturally, affords insufficient drainage for the abscess cavity and allows bowel infection to continue. The constant movements of the muscles in the region prevent the rest necessary for healing and so tend to aggravate the condition. The resulting sinus may point into the bowel or on the skin around the anus, and often both into bowel and skin by more than one opening, a complete fistula then being present.

Strictly speaking, the term *fistula* should be applied only where the track communicates with both bowel and exterior, while the term *sinus* is used when it communicates with either alone, and several types both of sinus and fistula have been described; but inasmuch as they are due to the same cause, and the sinus is merely an incomplete fistula calling for identical treatment, there is no useful purpose served by any detailed description, and the various forms are here only briefly enumerated.

A **complete fistula** is by far the commonest, in all cases is the terminal result of these conditions, and usually results from a pre-existing ischiorectal or pelvirectal abscess.

The track may be a simple straight tunnel passing from bowel to skin, but is more often a complicated granulating track, or series of tracks, which frequently pass back around the rectum (*horseshoe fistula*) and spread widely in the pelvic cellular and rectal submucous tissue. It is unusual to find a pelvirectal fistula passing through the levator ani, but it is a rare variety which must be borne in mind, as any attempt to lay such a fistula open throughout its length into the bowel will result in cutting the attachment of the levator to the rectum with permanent incontinence. More usually, as already stated, the pelvic abscess points into the bowel above the levator insertion, and is submucous only, from this point downward, in which case the track can be opened up with impunity. In old-standing cases the pelvic cellular tissue will be converted into a fibrous mass tunnelled with numerous fistulous tracks, often communicating with surrounding viscera, such as the bladder, urethra and vagina.

A **blind external fistula** is not common and is really a sinus which opens on the skin surface only; it may arise from an ischiorectal or submucous abscess which has discharged to the skin, and has no apparent communication with the bowel lumen.

A **blind internal fistula** is still less frequently seen and is a sinus communicating with the interior of the bowel, either from a pelvirectal or submucous abscess, which can usually be detected as a thickening beside the bowel, and pressure on which causes pus to ooze from the sinus mouth.

The condition is most often seen in tuberculous infections.

Fistula is extremely rare in women, and the few cases seen in the female are nearly always tuberculous.

Clinically, there is some tenesmus and pain, with a discharge of pus, which may be intermittent, but is later continuous and fæcal. The puckered mouth or mouths of the fistula can be detected around the anus, often in the posterior part, and in chronic cases much fibrosis may be detected with the eye and finger. In old-standing cases the whole area is a mass of fibrous tissue tunnelled with tracks from which pus continually oozes and which may communicate with surrounding hollow viscera.

Treatment. As already stated, early and free evacuation of pus in perirectal suppuration will do very much to prevent fistula formation. Once, however, the fistula or sinus is established, drastic surgical procedure is necessary as soon as possible in order to prevent tracking of the pus and the conversion of a simple to a horseshoe or complex fistula. If the track be straight the treatment is comparatively simple and the chances of success fairly good; the track is defined, a probe-pointed director passed up it into the bowel, and the whole laid open into the lumen of the bowel, the external sphincter being divided if necessary, care being taken to cut the fibres at right angles. Again, it cannot be emphasised too strongly that if in the case of a pelvirectal fistula the track passes through the levator ani muscle, the attachment of this to the rectal wall on no account must be divided or permanent incontinence results; in such a case a two-stage operation is necessary, the pelvic part of the track being first dealt with. The granulations are curetted, any spurting vessels ligatured, and the wound lightly plugged with sterile gauze soaked in paraffin. Should the track lie superficial to the external sphincter, this will not be divided, but it should be overstretched to ensure paralysis and rest to the part for a few days.

The patient should be kept in bed till the fistula is healed, sometimes one or two months, as movements prevent healing; the bowels must be moved daily with Conf. Sennæ, ʒii, o.n., or Liq. Paraffin, and baths given daily; after this plugging is lightly carried out until all danger of the track closing in superficially only is passed—this should be in a week or ten days if the track is freely laid open.

Fig. 272. Fistulæ around the anus.

During the operation the track must be examined carefully visually and with the probe, and all side tracks laid open freely and curetted; if they are very numerous deal with one side of the rectum alone and leave the other to be treated subsequently—as it is useless to open the main track unless *all* its branches are also dealt with. The same applies to horseshoe fistulæ, and here a word of warning is necessary as to multiple divisions of the sphincter ani, which should not be cut in more than two places at one time; care must be taken that the incisions are at right angles to the fibres of the muscle at the point of section in order to prevent a weak scar and partial incontinence.

In tuberculous fistula the whole track should be excised if possible, or freely curetted and cauterised with pure carbolic.

Partial operations, not involving section of the sphincter, are to be deprecated as they are seldom successful, the fistula recurring in a few weeks.

Fistulæ between the Rectum and other Hollow Viscera. **Recto-vesical fistula** in the male may be congenital, but is usually seen in old men as the result of diverticulitis or more rarely of carcinoma of the prostate or rectum involving the bowel and bladder or vice versa ; rarely a fistula may follow operation. There is intense cystitis, with pneumaturia, and later the urine runs away from the anus.

In congenital cases an attempt should be made to close the opening by a plastic operation, but success is rare. In malignant cases nothing can be achieved.

Recto-urethral fistula follows neglected fistula-in-ano and is most intractable.

Recto-vaginal fistula is not very rare, and may be congenital, when a colostomy is usually the only treatment. More often this condition is seen as a result of sloughing of the rectovaginal septum from the pressure of the fœtal head in labour, and attempts should be made to close the communication by a plastic operation, but often colostomy has to be carried out to cure the incontinence. Occasionally such a fistula results from ulceration of a carcinoma of the rectum or vagina.

Tubo-rectal fistula may follow the bursting of a pyosalpinx into the upper part of the rectum. Removal of the infected tube and closure of the small opening in the bowel are usually successful.

Recto-appendicular fistula usually occurs after the bursting of an abscess around a pelvic appendix into the rectum, and is uncommon. The treatment is as for tubo-rectal fistula.

HÆMORRHOIDS OR PILES

Piles or hæmorrhoids is the name given to the varicose and distended anastomosing radicles of the superior and inferior hæmorrhoidal veins in the submucous tissues of the lower end of the rectum and anal canal. It will be remembered that these veins run longitudinally in the submucous tissue, and that the superior hæmorrhoidal vein drains into the valveless portal circulation, while the inferior crosses the ischiorectal fossa to join the systemic system. Naturally any pressure and obstruction in the portal circulation is reflected to this most dependent point where the anastomosis occurs, and to a lesser extent this applies to the systemic circulation, but only when the valves become functionless in the veins. Any distension of these venous radicles causes them to bulge into the lumen of the bowel, where they present as a series of oval purplish swellings from which the blood is readily expressed on pressure unless clotting has occurred ; *piles therefore are not normally detectable on digital examination of the rectum.*

When the distension is in the portal circulation—*i.e.*, the lower end of the rectum—the piles are called internal piles ; when in the systemic circulation, *i.e.*, perianal—external piles. The former are covered by mucous membrane, the latter by skin.

(A) **Internal piles,** as might be expected from the valveless condition of the veins of the portal circulation, are very much the commoner and indeed for all practical purposes constitute " piles." They are covered with columnar epithelium, but if of long standing this may degenerate and become stratified in type.

Normally they form a series of purplish ovoid bulges in the lower rectum (Fig. 271), which may feel full and soft on digital examination, and there may be some mucoid discharge, with, sooner or later, hæmorrhage of a bright red colour from injury to the pile by hard fæces during defæcation ;

this is the more likely as obstinate constipation is the rule in these cases. This hæmorrhage may be small in amount and infrequent, but is often severe and recurrent, so that the patient becomes very anæmic. Infection is a frequent complication, and this leads to thrombosis of the pile, which becomes hard and tender and is often protruded through the anus during defæcation; such a *thrombosed pile* may have to be replaced digitally.

Apart from this, during the straining at stool the piles and mucosa may be forced down and gripped by the sphincter ani, which strangulates the *prolapsed piles*, with the result that they become thrombosed, and present as semisolid, jelly-like nodules of a plum colour protruding from the anus. Such a condition becomes increasingly likely to relapse, the piles becoming thrombosed and presenting as a series of hard, rounded nodules easily detected on rectal examination.

Either thrombosis or prolapse constitutes what is popularly known as an "attack of piles," and is always accompanied by tenesmus and obstinate constipation.

Suppuration may occur, either locally, when a submucous abscess forms, or in the lymph nodes in the ischiorectal fossa, when an ischiorectal abscess results. The frequency with which fistula-in-ano is associated with piles is thus explained. *Suppurative pylephlebitis* is a serious and not very rare complication, which is more liable to occur if any operation is undertaken on inflamed piles, and is almost invariably fatal.

The condition is usually seen in adults, both sexes being equally and commonly affected, especially in those, such as clerks, who follow a sedentary occupation. It cannot be impressed too strongly on the student that in every case of piles a very thorough examination of the rectum must be made, for, as will be seen below, many causes predispose to this condition. Especial care is required in cases where an elderly person complains of sudden onset of piles, as carcinoma of the rectum or colon are to be suspected, and in all such cases sigmoidoscopy is essential if no growth is revealed on digital examination.

Briefly to recapitulate, three stages of piles are met with :—

(1) The piles remain above sphincter, but may bleed freely.

(2) The piles prolapse and thrombose, and may require digital reposition; bleeding is severe during these attacks of piles.

(3) The chronically inflamed piles present as a series of thickened nodules, usually covered by stratified epithelium and fibrous tissue. There is more or less chronic prolapse, but owing to the scarring bleeding is slight or absent. This condition succeeds repeated attacks of infection after thrombosis or strangulation, and is often complicated by fistula-in-ano following imperfect drainage of the resultant ischiorectal abscesses.

Diagnosis. It is usually easy to establish the fact that a patient has piles, as the condition is generally specifically complained of, but a thorough examination should be made always, as any swelling around the anus is apt to be described as piles. *Condylomata* are frequently so designated, and careful examination may be necessary to make a correct diagnosis, but this is always possible, as other signs of secondary syphilis will be present.

Rectal prolapse presents a smooth annular mass unless associated, as it often is, with piles, when nodules are present and the treatment of both conditions is operative.

Prolapsed adenoma (rectal polyp, see p. 798) is commonly seen in children, in whom piles are rare; it is firmer and definitely pedunculated, projecting through the anal orifice with no prolapse.

Intussusception rarely reaches the stage of prolapse per anum before diagnosis. It is occasionally seen in infants who are acutely ill with a sloughing mass, in which the bowel lumen may be detected, projecting through the anus, between which and the mass the finger can be passed on all sides.

Masses of *granulation tissue* may protrude from the anus, in *Bilharziosis*, and occasionally in *Yaws*.

Apart from these conditions nothing is likely to be mistaken for piles, but having diagnosed hæmorrhoids it is essential to ascertain their cause before proceeding to treatment. There are four causes of hæmorrhoids :—

1. Obstruction of the portal circulation.
2. Obstruction of the local circulation in the pelvis :—
    - (*a*) By obstruction in the bowel wall.
    - (*b*) By pressure without the bowel.
3. Obstruction (severe) in the systemic circulation.
4. Idiopathic hæmorrhoids so called, associated with and aggravated by chronic constipation, and probably due to the drag of the chronically overloaded pelvic colon obstructing the venous return at the pelvi-rectal juncture.

It is essential to eliminate and deal with any causes in the first three groups before a diagnosis of idiopathic piles can be made and the local condition dealt with.

(1) Obstruction in the portal circulation, usually in the liver, is commonly due to hepatic cirrhosis, or to secondary carcinoma (rarely primary) in this organ. Rarer conditions are Gaucher's splenomegaly, Banti's disease, splenic anæmia, and any other condition causing hepatic or splenic congestion.

(2) Obstruction in the pelvis : (*a*) in the bowel wall, is nearly always due to carcinoma of rectum, but also occurs in association with fibrotic strictures after dysenteric, bilharzial, gonorrhœal or traumatic proctitis.

(*b*) Outside the bowel, is most often seen in women due to pressure from the pregnant uterus, which is a very common cause of piles in young women. Ovarian cysts, fibroids of the uterus, hydatids, or mesenteric tumours may also cause hæmorrhoids, while in old men they may result from pressure from an enlarged prostate.

(3) Systemic back pressure, with which is also associated portal back pressure, occurs in severe valvular disease of the heart, when compensation is lost. It also occurs rarely in conditions such as fibrosis in the ischiorectal fossa, or chronic lymphatic enlargement, where pressure is exerted on the inferior hæmorrhoidal veins.

When these possible causes have been eliminated, then idiopathic piles can safely be diagnosed, and it will be found generally that the anus is rather patulous, and the mucosa lax, thickened and œdematous. Chronic constipation is always present, and in old-standing cases marked anæmia and an earthy complexion are met with, while a certain amount of rectal prolapse usually coexists.

Treatment. In cases other than idiopathic, local treatment should be palliative only while the primary cause is dealt with, when the piles will clear up in time. In severe piles from cirrhosis injection or removal may be justifiable, but the patient must be warned that recurrence is inevitable in a few months. In all cases the constipation requires attention, and must be corrected and the bowels must be regularly attended to for all time ; vigorous purges are to be avoided, and gentle regular laxatives should be given, of which the best is fresh Conf. Sennæ ʒi or ii o.n., or this can be given with an equal amount of Conf. Sulphur nightly; some prefer Senna Tea (pods 12–24) taken on awakening, others Liquid Paraffin or Cascara, and these must continue to be taken regularly and indefinitely, for if constipation recurs, local relapse of the piles is inevitable.

Local treatment, apart from the relief afforded by regular purgation, consists either in palliative or operative procedures:—

(*a*) *Palliative treatment* is directed to the arrest of bleeding and prevention of infection, and always must start with procuring regular action of the bowels, after which the anus must be cleansed carefully with cotton wool and warm water. An astringent ointment, such as Ung. Gallæ c̄ Opio, or better Ung. Hamamelidis, may be applied to the piles, and care must be taken to direct the patient to introduce ointment with the finger or a nozzle through the anus into the lower rectum. Astringent suppositories are a useful form in which drugs can be applied to the lower rectum and anal canal, one is introduced nightly, on going to bed, and will have dissolved by morning. Some means may be employed to irritate and so fibrose and thicken the mucosa, such as the regular introduction of a rounded vulcanite or ebony rod of the type of the "Little Wonder," which is rubbed up and down and may be successful in slight cases.

In more severe cases, even when there is a tendency to slight prolapse on defæcation, provided the piles return inside naturally, some means such as the injection of an irritant into the submucous tissue may be employed usefully to promote clotting and fibrosis. Of these much the most satisfactory and safe is *carbolic injection*, which can be carried out safely on the consulting room couch and almost painlessly, provided the injection is made through mucous membrane and not skin. The patient lies on the side with the knees drawn up, and the lower rectum is exposed by means of a speculum with a side panel, through the side of which the pile will bulge when the panel is withdrawn; two or three piles can be treated at one sitting without causing subsequent discomfort, and the patient may proceed home, but should be warned against taking violent exercise for the rest of the day.

Two to five minims of the following solution are injected with a long needle into the submucous tissue around the pile, and the subsequent thrombosis will ensure cessation of bleeding:—

℞ Ac. Carbolic
Glycerin
Aq. destill. aa ℥i.
♏ii–v to be injected around each pile.

The immediate results are satisfactory, but usually relapse occurs in from six months to a year, often from the development of new varicose veins. The treatment never should be employed where prolapse is present to any extent or thrombosis has occurred, as these will remain and the patient derive no benefit. In such cases operation alone offers chance of success.

(*b*) *Operative Treatment.* (i.) The operation in most general use, and one which gives on the whole very good results, is *ligature,* which is best associated with *excision of the pile* beyond the ligature, for this relieves the pain caused by the presence of the tense thrombosed hæmorrhoid. The patient, who should be prepared by a dose of castor oil the night before and given two enemata, one four hours and the other one hour before operation, is placed in the lithotomy position, previously having been anæsthetised. The finger is inserted in the anus and the piles can be coaxed outside, a proceeding which saves stretching the sphincter ani and thus causing the patient subsequent pain. (Should a fissure-in-ano be present the sphincter must be stretched.) The piles are then grasped separately in forceps, which are applied longitudinally on the bowel (*i.e.*, along the pile), and ligatured, the skin being cut before the ligature is applied, but not the mucous membrane. Some surgeons prefer to transfix the pile, but this is not necessary if stout ligature material is used and it is pulled tight as the forceps are withdrawn. In any case, not more than three or four piles must be ligatured for fear of causing a fibrous stricture of the bowel.

The redundant tissue is then cut away distally to the ligature, and this cut short, the pile stumps being returned through the anal sphincter. Plugging and the insertion of a tube through the anus are unnecessary, and should be avoided as they cause great discomfort.

Subsequent to this and any operation for piles or fistula, the *after-treatment* is best carried out on the following lines. Pain will be severe if much skin has been crushed and morphia may be given as required, some surgeons preferring to put a morphia suppository, gr. ⅓, into the bowel at operation, while others find that the injection of a local anæsthetic, such as A.B.A., into the ischiorectal fossa is of benefit. On the morning subsequent to operation the patient should be sat in a hot bath, which will give him great comfort, and usually enable him to pass urine should retention be present, though this seldom occurs if the anal sphincter has not been stretched. The baths should be continued daily until healing has occurred, usually fourteen to twenty-one days.

On the second night, *i.e.*, the day after operation, Mist. Sennæ Co., ℥i, should be given to open the bowels ; this is more satisfactory than Ol. Ric., and does not tend to constipate afterwards. This gives the patient a soft and easy motion, evacuates wind, and ensures subsequent comfort, the bowels being kept open regularly thereafter by a nightly dose of Conf. Sennæ, ʒii, or Liq. Paraffin. This will be found to give much better results, especially in regard to the patient's comfort, than the older method of keeping the bowels shut for several days and then assisting a constipated action with an olive oil enema.

The patient should be kept in bed for at least fourteen days, and better three weeks, in order to ensure non-recurrence, and, moreover, must be impressed with the necessity of securing regular daily evacuation of the bowel in the future, so as to avoid return of the piles.

(ii.) If much prolapse is present, as is the case in most old-standing piles, then some modification of *Whitehead's Operation* gives excellent results. This should never be attempted unless there is enough laxity of the mucous membrane to ensure that no tension exists on the stitches uniting skin and mucosa after excision of a ring of mucous membrane with the subjacent piles. If tension exists the mucosa will retract and a raw area be left, with subsequent formation of a distressing rectal stricture (p. 784), and for this reason it is safer to unite the cut edges with a series of hæmostatic mattress sutures rather than use a continuous stitch, which, if it gives at one place, will allow the whole bowel to retract. For some three or four weeks anal sensation is lost, so that the patient is not sure whether fæces or flatus are being passed, but this distressing complication is only temporary.

(iii.) Another method, not now much used, is the *clamp and cautery*, the piles being seized in an ivory clamp and seared away with an actual or electric cautery. A useful modern modification of this is to plunge a thick diathermy needle into each pile, when thrombosis and sloughing result. Either method is, on the whole, less painful than ligature, even when accompanied by excision, but special apparatus is required.

(B) **External piles** are of little import and consist of a distension of the radicles of the inferior hæmorrhoidal veins at the anal orifice and in the perianal rugæ, which area looks, in consequence, puffy, bluish, and unduly prominent and turgid. The condition is often present in constipated women, and causes no trouble unless one of the piles thromboses, when it presents as an elongated, hard, purplish and tender swelling, with pain on defæcation. Pruritus ani may be present.

The *treatment* consists in curing constipation, employing care in cleanliness after defæcation, and the use of Ung. Hamamelidis. Should thrombosis occur an incision may be made over the pile and the clot be turned out.

RECTAL PROLAPSE

A partial prolapse of the rectal mucosa normally occurs during defæcation, the mucous membrane retracting above the sphincter on completion of the act unless some abnormal process, such as the presence of hæmorrhoids or undue weakness of the pelvic muscles, prevents this, when the condition of pathological prolapse is observed. Two common causes of prolapse of the rectum exist:—

(1) The one commoner in young children, often with marasmus from tuberculous peritonitis, is weakness of the sphincters and levatores ani (pelvic diaphragm), which, if present in diseases where the fat in the perirectal tissues and ischiorectal fossæ has been absorbed, is always accompanied by prolapse. A similar condition is seen in women who have had the pelvic diaphragm weakened or torn in childbirth, and is often accompanied by uterine prolapse (Chapter XXII., p. 969).

(2) The other, more frequent in adults, is due to chronic constipation, and very commonly the added irritation of prolapsed piles, which unduly draw down the rectal wall during defæcation and retard its return within the sphincter ani. In children, sometimes threadworms may act as a local irritant, and both in children and adults a retained foreign body or any local cause of rectal irritation, such as polyp or enlarged prostate, or severe diarrhœa, often will predispose to a prolapse of this type. Hæmorrhoids are the commonest cause, and if chronic are always accompanied by some degree of rectal prolapse. The condition occurs not uncommonly some months or years after operations for removal of the prostate.

Whatever the cause, be it muscle weakness or irritant in the bowel, the prolapse at first consists of mucous membrane only, and is then said to be "*incomplete*," but later, if the cause persists and the condition is untreated, the whole rectal wall will protrude through the sphincter ani, sometimes to an extent of 10 inches, when the prolapse is "*complete*." As a general rule, prolapse due to local irritation remains in the incomplete stage, and seldom projects more than an inch or so, whereas prolapse following on weakening of the pelvic muscles soon becomes complete, and if extensive drags down the inverted "pouch of Douglas" on its anterior aspect; this peritoneal cul-de-sac may contain coils of small bowel, which if they become nipped by the sphincter give rise to signs of intestinal obstruction (Chapter XVI.).

Clinically, in the incomplete stage the prolapse is often self-reducing, or may be returned by the patient after defæcation, but the anus is usually patulous, and the perianal region unduly soggy and the rugæ prominent. Later the prolapse becomes more or less permanent, as it is from the very early stages where weakness of the pelvic diaphragm is the predisposing cause, or where, as in cholera, acute rectal irritation coexists, with great exhaustion; if the sphincters be sufficiently strong it may become nipped and partially strangulated. In the anal orifice there then lies a rounded or conical swelling, covered with red mucosa, on the surface of which glairy mucoid secretion is seen. If gripped the colour is maroon or dark purple, œdema may be present, and much mucus or mucopus is secreted, together with some blood. In old-standing cases the epithelium loses its velvety appearance and may resemble skin in consistence, while superficial ulceration is often present over the mass. More or less incontinence of fæces is usually present in cases where muscular weakness exists.

The edge of the protrusion is continuous with the skin around the anal margin, and at its apex the slit-like lumen of the bowel can be seen and the finger inserted into it. In the early stages reduction by manipulation is easy, but later, especially if the sphincter tone be good, or much œdema present in the prolapse, it may be difficult. Rarely sloughing of the protruded bowel occurs, when spontaneous cure may result; but if in a complete prolapse the peritoneum of Douglas's pouch be opened and infected, death may follow from generalised or localised peritonitis.

Diagnosis. This is usually easy, the only conditions likely to cause error being (1) a prolapsed rectal adenoma (polyp) or (2) a protruded (and sloughing) intussusception, in both of which the finger can be passed between the anal margin and the protrusion, and in the former of which no bowel lumen can be detected.

It is essential to ascertain the cause of the prolapse, and if due to weakness of the pelvic diaphragm, to find whether there is also prolapse of other pelvic viscera and whether the weakness is due to a local lesion or general asthenia. Any local cause of irritation must be noted, such as piles, enlarged prostate, phimosis, etc.

Treatment. This must be directed primarily to removal of any local irritant, such as chronic constipation, polypus, piles, worms, phimosis, or enlarged prostate. If due to muscle weakness, then this must be dealt with promptly to prevent the prolapse becoming complete; thus in children defæcation should be performed in the supine position, and the buttocks strapped after the act, the child meanwhile being fattened with cod-liver oil, and faradism employed to tone up the perineal muscles. In adults, usually multiparous women, ruptured perineal muscles must be repaired, the other pelvic viscera supported, and, if necessary, operation undertaken for the prolapse.

Operation is seldom, if ever, necessary in children, where the treatment already advocated suffices in all cases, and the prolapse ceases so soon as the child fattens. In adults, however, once the prolapse is complete, success seldom crowns palliative measures; it is, indeed, not often met with after operation, which, however, offers a better chance of cure.

In slight cases good results often follow linear cauterisation of the prolapsed bowel, but in complete prolapse this is of no use.

In severe cases two procedures alone are likely to give success:—

(*a*) *Lockhart Mummery's Operation,* which consists in making a curved incision around the posterior aspect of the anus, dividing the weak coccygeus muscle, disturbing the weakened perirectal tissue, replacing the bowel and holding it up in position by plugging into the wound around it. The plugs are left in position several days, and a brisk inflammatory reaction, often with suppuration, ensues, with resulting perirectal fibrosis, which usually much ameliorates, though seldom cures, the prolapse.

(*b*) *Excision of an annular portion* of the prolapsed bowel and suture of the cut upper end to the skin margin. Care must be taken in this case that if possible the pouch of Douglas is not opened, and that if it is, careful suture is carried out; also that the sphincters are not removed, and above all that the insertion of the levator ani into the rectal wall is undisturbed, or incontinence will ensue. It will be seen thus that such operations really limit themselves to excision of mucosa, and that as suppuration often ensues, perirectal fibrosis will result and a stricture may occur in the bowel. On the whole the results are more satisfactory than those from any other operation.

Proctopexy and colopexy to fix the pelvirectal junction are generally admitted to be of no value as curative operations.

Reduction of an actual prolapse is usually easy, and if any difficulty be experienced owing to its bulk or inflammatory changes, an anæsthetic will render return of the protrusion possible. In either case manipulation with gloved hands is much facilitated by the use of a lubricant, and the upper portion of the prolapse should be returned first.

After reduction the buttocks may be strapped together and the part raised on cushions, but the prolapse usually recurs with defæcation, after which immediate reduction must be undertaken regularly.

In all cases after operation or reduction the patient must be confined to bed for three weeks or a month, the bowels opened daily by some mild laxative, such as Paraffin Liq. or Conf. Sennæ, the patient evacuating into a bed-pan.

Morphia may be given for the rather severe post-operative pain.

Pruritus ani is a distressing condition where intense itching is complained of in the anus and natal cleft, which, if allowed to become chronic, proves one of the most irritating and intractable of the afflictions of mankind. It is usually present at first only at night, but later becomes constant, though always worse at night and in warm weather, preventing the patient from sleeping or resting.

Usually some local cause of irritation is present, and all such should be removed promptly if pruritus be complained of; hæmorrhoids, fistulæ, fissure-in-ano, prolapse, threadworms, condylomata, warts, eczema, and in women vaginal discharge are commonly met with. In other cases, however, no definite local cause can be found, and this is frequently so in patients with diabetes and gout, where treatment of the disease often results in amelioration of the itching. There are, however, cases where no apparent cause is discernible, and others of old standing where a central nervous irritability has been established and no local treatment is likely to have a beneficial effect.

Clinically the patient scratches and pulls at the perineum continuously, so that the perianal region becomes œdematous and abraded, and often septic, with consequent aggravation of the itching. It is usually useless to hope that scratching will be abandoned, but attempts should be made to get the patient to desist. Often the perianal skin has a characteristic atrophic, smooth, parchment-like appearance.

Treatment. To be successful this must be undertaken early; it consists in removal of any local cause of irritation, and the treatment of diabetes or gout if present. Creolin lotion or Ung. Ac. Salicyl. form useful local applications. Injections of a local anæsthetic in an oil basis such as proctocaine will often relieve the condition for a long time.

In more intractable cases, X-rays or radium radiations often effect at least a temporary cure, by destruction of local nerve endings, and a similar result may be hoped for by the performance of *Ball's Operation,* which consists in making a semicircular incision about 1 inch from the mucocutaneous margin on either side of the anus, and undercutting up to and around the anal orifice so as to destroy the cutaneous nerves.

Fæcal incontinence may be seen as the result of :—

(1) Extreme asthenia in severe illnesses.

(2) Disease of the central nervous system.

(3) Injury to the brain or spinal cord, or to the nerves to the muscles of the pelvic floor.

(4) Injury or palsy of the levatores ani and sphincter muscles.

(5) Impending death.

(6) Extreme fear.

(7) Collapse or shock.

This consists in an involuntary and usually unrealised passage of fæces, and often urine, which may be periodic or continuous; fæcal incontinence may be absent if constipation be present, and only noticed when the motions are loose. Many of the cases do not come within the sphere of the surgeon, and others it is not in his power to ameliorate. In cases due to local injury to the sphincter muscles he may be able by judicious repair to effect a cure, while, as already emphasised, in operations on the bowel he must never sever the insertion of the levatores ani and internal sphincter into the lower rectal wall near the anorectal junction, or incontinence of fæces will be the inevitable and lasting result.

Treatment will vary with the cause, repair operations being undertaken to suture the muscles in rupture of the perineum after childbirth ; or in old-standing cases a new sphincter may be formed from slips turned across from the levatores ani or gluteus maximus muscles. In cases such as fracture of the spine, concussion, etc., where no local treatment is indicated, bedsores must be prevented by careful nursing and constant local attention to cleanliness ; the patient with advantage may be kept on a rubber ring, the centre of which is floored and constitutes a bed-pan.

NEOPLASMS OF THE RECTUM AND ANUS

Tumours of the rectum are nearly all epithelial in origin, connective tissue tumours, which may start in the submucous tissue or around the bowel, being excessively rare.

(A) *Simple Tumours.*

(1) **Adenoma** of the rectum is the most common simple growth and met with usually in children of from two to seven years, though it may occur at any age. The tumour is usually of the size of a hazel nut, but may be larger or smaller, and is often pedunculated, thus earning for itself the name of **rectal polyp,** by which it is usually known.

In adults there is a distinct tendency for a rectal adenoma to become malignant, and many cases of carcinoma of the rectum will be found to have one or more adenomata in the mucous membrane above the carcinoma.

The growth may be single, but multiple tumours are by no means uncommon, and should be looked for. The neoplasm consists of a soft red mass covered with columnar epithelium, slightly lobulated and projecting into the rectum on a pedicle which elongates and becomes more defined as time goes on, and along which the free blood supply enters the growth. The mass is friable and bleeds easily, while mucus is secreted from the many tube-like glands in its substance. In old-standing cases the pedicle may become sufficiently elongated to allow the adenoma to prolapse through the anus at defæcation, when it often becomes nipped by the sphincter and may strangulate and slough, thus effecting a spontaneous cure.

Clinically there is usually a history of the passage of bright blood per rectum during and between defæcation, and there may be excessive mucoid discharge, pruritus ani and tenesmus. If prolapsed, the polyp presents as a red or purplish soft, rounded mass, rather like a cherry in appearance ; the finger can be passed into the anus around it and the pedicle detected. Rectal examination, both digital and visual, will reveal the presence of one or more adenomata, and often excites bleeding.

Treatment. This consists in grasping the polyp in forceps, twisting the pedicle and snipping it through ; should it be thick a ligature must be applied, but this is not usually necessary. Search should be made for other polypi.

Prolapsed hæmorrhoids or intussusceptions can be mistaken only for adenomatous polyps on a very superficial examination, and no errors should arise in diagnosis.

(2) **Papilloma.** This is of rare occurrence and is met with usually in adults,

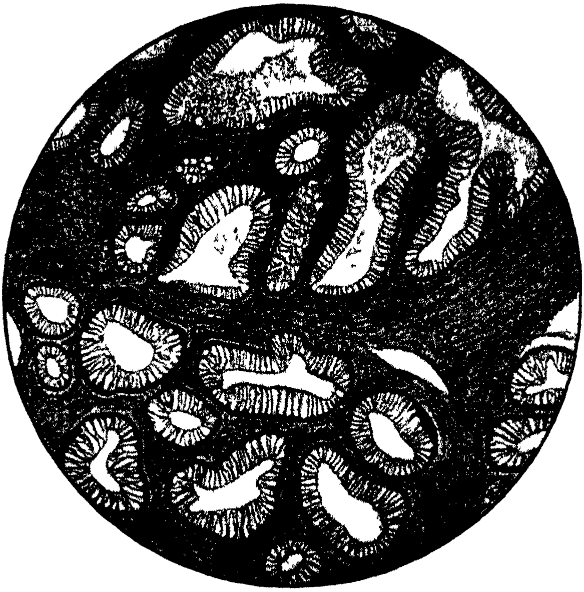


Fig. 273. Adenoma (columnar-celled). × 45. "Rectal polyp."

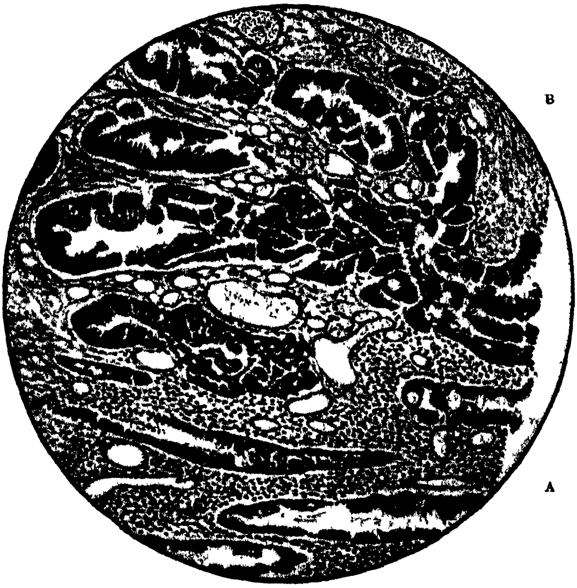


Fig. 274. Carcinoma of rectum. × 55. A. Normal glands. B. Carcinoma.

where it causes excessive bleeding; it presents as a diffuse papilliferous, sessile, reddish mass, which may involve much of the rectal wall, and is liable to be mistaken for carcinoma, of which, when present, it is a frequent precursor. Microscopy alone can establish a definite diagnosis. The condition is often associated with the diffuse adenomata in the colon (p. 669).

Clinically there is severe bleeding, with often serious anæmia. Prolapse of the raw, red mass is not uncommon. Rectal examination reveals a soft, bleeding, villous mass, usually extending up and around the greater part of the rectal wall.

Treatment is not satisfactory, and probably cauterisation with the diathermy apparatus or excision of the mucosa with a diathermy knife gives the best results; but rectal stricture or carcinoma are liable to supervene. Excision with scissors or the knife causes severe hæmorrhage and yields poor results. The rectum has been removed in extensive cases, while radium has given promising results.

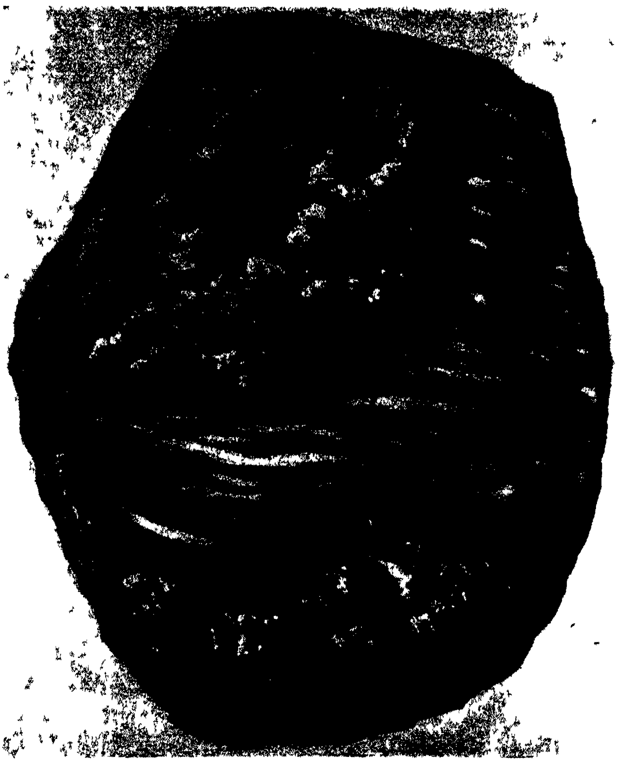


FIG. 275. Fungating carcinoma of the rectum, with an ulcerating "seedling growth at the anus.

(3) **Simple connective tissue neoplasms** may be met with in the submucous tissue, and include fibroma, lipoma and hæmangioma, which last causes severe hæmorrhage and may be mistaken for a papilloma. They are, however, very uncommon and merit no further mention. Thrombosed and fibrosed hæmorrhoids occur in the submucous tissue of the lower end of the rectum, and must not be diagnosed as fibromata.

(B) *Malignant Tumours.*

1. **Carcinoma of the rectum** may commence anywhere in the wall of the bowel and is always of the columnar-celled type.

Pathologically four types are commonly met with and are of interest as the type gives a good guide to prognosis :—

(*a*) About 80 per cent. of carcinomata are of the ulcerative type accompanied by more or less fibrosis. The ulcer tends to spread slowly around the bowel, taking usually eighteen months to two years completely to encircle it, and causing no obstructive signs until it has been present for at least six months. This type tends to disseminate widely and early, so that the prognosis is poor.

(*b*) A papilliferous type occurs in about 15 per cent. of cases and chokes the bowel with a mass of growth, so that obstruction occurs early. In these cases dissemination is very slow, the growth being apparently only locally malignant, and the prognosis as regards life is good, many cases surviving for seven or ten years after a colostomy only.

(*c*) Colloid carcinoma is very malignant, obstruction occurs early, and death usually occurs from metastases within a year.

(*d*) Melanotic cancer is the most malignant type, death occurring usually in a few months. It is sometimes difficult to see the melanin in the primary growth as it is deposited in patches and easy to miss in microscopic sections.

It is probable that some cases arise from simple adenomata, and it is quite common to see one or more adenomatous polypi growing from the bowel near or above a carcinoma. There is usually considerable local reaction, with fibrosis in and around the tumour, so that not only is there much thickening and induration of the rectal wall, wherein the growth often shows as a plaque-like mass running in the submucous tissue, but a rectal stricture is prone to develop, with signs of increasing intestinal obstruction. Later the tumour ulcerates and presents a typical sloughing ulcer with hard, raised, everted edges, set in the strictured and contracted bowel wall, which it often encircles in an annular manner.

Less commonly the neoplasm is more rapidly growing, the destruction keeping pace with the growth of the carcinoma, and in these cases a deep, burrowing ulcer with hard, everted edges forms rapidly and penetrates through the rectal wall. Stricture does not then occur, and intestinal obstruction is never seen in this ulcerative variety of carcinoma, though there is usually severe bleeding and tenesmus. Still more uncommon is the variety of carcinoma which presents as a polypoid mass invading the bowel wall at its base.

As the growth invades the rectal wall in either the fibrotic or ulcerative type, nerves and vessels become involved and destroyed, so that (1) the bowel wall becomes paralytic, atonic and ballooned below the neoplasm; (2) piles frequently develop. Later, the surrounding tissues become invaded; thus the bladder, prostate or urethra in the male may be involved, with formation of a rectovesical or recto-urethral fistula and the passage of flatus in the infected urine, while in the female rectovaginal fistula is by no means uncommon. The pelvic fascia also becomes invaded and the structures lying therein, so that involvement of the branches of the sacral plexus, with resultant referred sciatic pain, is by no means uncommon, while invasion of the iliac vessels may lead to death from hæmorrhage; more rarely muscles and bones may be involved by the direct extension.

It must be remembered that ulceration in connection with the bowel is necessarily a septic process, with secondary infection of the neoplasm from the fæces, so that extensive inflammatory changes, with fixation and thickening of the surrounding tissues, will also occur from this. It is very difficult clinically to determine how much of the fixation is due to inflammatory reaction and how much to infiltration of the adjacent tissues by growth, so that operative treatment often will give good results in apparently hopeless cases, and, similarly, fæcal fistula may be secondary to the bursting of abscesses.

Lymphatic involvement is early, and the nodes affected are in the perirectal tissues of the sacral hollow, whence the lymph stream infects the iliac and then the lumbar nodes; these lie in the retroperitoneal tissue and are not palpable on abdominal examination, except in very thin subjects. Invasion of the peritoneum of the pouch of Douglas is not uncommon, and is probably lymphatic in origin, the carcinoma presenting at first as pearly nodules scattered on the pelvic peritoneum, which later coalesce to form a white plaque; the presence of such metastases, of course, will contra-indicate any radical removal of the primary growth. In the later stages hepatic and omental secondaries will cause jaundice and ascites.

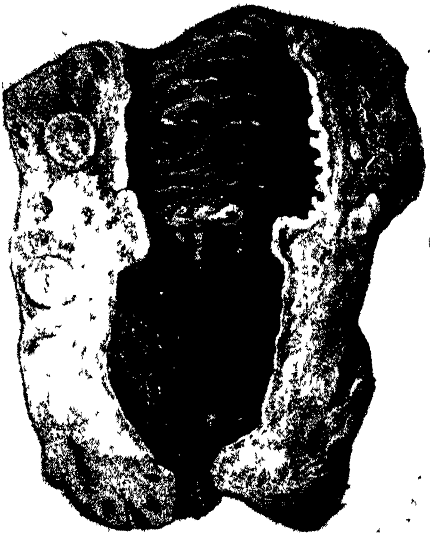


FIG. 276. Advanced carcinomatous ulceration of the rectum with extensive infiltration of the perirectal cellular tissue and lymph nodes.

Clinically, rectal carcinoma is a disease usually seen in people over forty, and more often over sixty, though it may occur as early as ten years of age. Both sexes are about equally liable to it, but the growth is probably rather more frequent in men. The onset is usually very insidious, there being some slight loss of weight and lack of energy, which may be observed long before any local signs are manifest. Campbell de Morgan's spots may occur at this stage, and their presence always should lead to a grave suspicion that a carcinoma is present.

Sooner or later slight local signs appear; probably the first symptom is a sensation of discomfort in the rectum, a feeling after the bowels have acted as though there is still matter remaining to come away: after this the abdomen may be noticed to be slightly distended, flatus is unduly in evidence, as also are borborygmi; the cæcum is often distended and gurgles on manipulation, and the colon can be felt distended in the left iliac fossa. Signs of rectal irritation may be present, the earliest and most characteristic of which is "morning diarrhœa" (the mucus and fæcal matter in the bowel, which accumulate in the night, cause the patient to rush and defæcate immediately on rising from bed); some tenesmus, bleeding or spurious diarrhœa, with offensive liquid stools, may be noticed, alternating with periods of constipation, and any such symptoms necessitate the performance of a thorough rectal examination without delay. Hæmorrhoids may be complained of, and it cannot be emphasised too strongly that their recent appearance in any patient over forty necessitates a rectal examination being made, and calls urgently for sigmoidoscopy if the finger yields negative results. Acute obstruction may supervene in the fibrotic type from blockage of the stricture by a mass of solid fæces, but if left alone this nearly always subsides as the fæcal mass decomposes and liquefies. In the ulcerative type much mucus is secreted and bleeding is common, so that there is frequent passage of blood-stained mucus, with considerable tenesmus.

Later, surrounding viscera may be involved with the formation of fistulæ, or great pain from sciatic invasion, and again it cannot be impressed sufficiently on the practitioner how necessary it is to do a rectal examination in every case of " sciatica " ; especially is this so when the pain is bilateral.

Bleeding does not occur till the growth ulcerates, and is therefore a late sign, and alteration in the shape of the motions only occurs if the anus is involved, and therefore should not be expected except when the carcinoma is quite in the lowest part of the rectum.

Rectal examination never should be neglected, and must be made at the earliest opportunity. The finger should be introduced, when a hard plaque, often encircling the bowel, can be felt in the rectal wall, fixing and involving the mucous membrane, and often a craggy ulcer may be detected; every effort must be made to ascertain to what extent the growth is fixed to surrounding structures, for on this depends the line of treatment to be adopted. As already pointed out (p. 777), a considerably increased length of the bowel can be palpated if the examination is performed with the patient in the squatting position. Should nothing be palpable, but the bowel be ballooned and atonic, and the rectum empty or containing a little offensive liquid, a sigmoidoscopy must be performed. If a mass of hard scybala or formed fæces be present, the case is one of chronic constipation, and the patient may be reassured and treated accordingly.

Should rectal examination by the finger be negative a proctoscopy must be undertaken and will certainly reveal any growth below the recto-sigmoid junction. A barium enema and X-ray film are of little value except to detect growths at or above the recto-sigmoid junction.

Diagnosis. This is usually obvious on rectal examination, but all too often the case is misdiagnosed, or diagnosed too late for cure, because this simple examination is omitted.

Tuberculous and syphilitic disease occur occasionally, and if of the chronic hypertrophic type may be mistaken for carcinoma; indeed, usually only microscopic examination can establish a diagnosis. In women the tyro is apt to mistake for carcinoma the cervix uteri, especially if this is rough and lacerated; for it can be felt through the anterior rectal wall, into which it often projects ; but the rectal mucosa is normal, intact, and moves over the rounded mass.

Carcinomata of the colon and pelvirectal junction may be palpated through the normal rectum, as also prostatic, ovarian and uterine abnormalities, but, with the exception of carcinoma of the prostate, none of these involves the rectal mucous membrane, which is normal in feel and moves freely over the swelling, which lies outside the bowel wall.

Prognosis. Cases usually live two years after the onset of the disease, and colostomy, except obstructive signs be present, does not prolong life. In some cases, especially those with papilliferous proliferation (p. 801), the patient may live in comparative comfort for five to ten years. Operation, if successful, will of course prolong life, but recurrence is common in from three to five years.

Treatment. If the growth is mobile, or the surrounding structures not obviously infiltrated and the patient otherwise healthy, the carcinoma should be removed, together with the bowel wall, and as much of the lymphatic drainage area as possible.

This operation should be preceded always by a *colostomy* (p. 699), which should be performed high up in the abdominal wall, if possible in the pelvic colon, and the bowel be washed out daily for at least ten days before removal of the growth is attempted. The colostomy in most cases will remain permanently open, and can be closed only in the few cases where end-to-end anastomosis of the bowel wall can be performed above an intact anal sphincter; for colostomy is preferable to an incontinent perineal or sacral anus. Should secondary peritoneal or hepatic deposits be palpated, the growth be found to be very fixed when examined from above or the patient be found to stand operation badly, then the removal of the rectum will not be performed; in cases other than those with obstructive signs, colostomy need not be carried out unless the surgeon thinks fit.

Diathermy may be employed with advantage in inoperable cases, and lessens both pain and discharge. In addition, some apparently inoperable growths shrink and become mobile, so that they can be excised subsequently.

Personally we do not advocate colostomy (except as a preliminary to excision) unless obstructive symptoms predominate, as it does little to alleviate the local irritation and discharge, the continuance of which, added to the colostomy, may prove the last straw to an already depressed patient.

There are three varieties of operation which may be carried out for excision of carcinoma of the rectum, all of which involve removal of a certain amount of healthy bowel wall, and some excision of infected lymphatics. Recently it has become the practice more and more to perform these operations by means of avertin and spinal anæsthesia.

(1) **Abdominal and abdomino-perineal methods** may be described together, as the former is only the first stage of the latter. They give the best chance of an adequate removal of the lymphatic area, and so offer a chance of radical cure; the operation is a severe one and should not be performed on debilitated subjects, and especially on those whose diastolic and systolic blood pressures show little difference. Even in expert hands the operative mortality is in the region of 20 per cent., but the chances of recurrence are slight. At a first operation a colostomy is usually performed, the bowel being completely severed and the lower end invaginated with a purse-string suture and dropped back into the abdomen. The subsequent removal of the rectum is undertaken some ten days later; previous to operation the colostomy is shut off from the area of the incision by a sheet of jaconet secured transversely to the abdominal wall by strapping applied across below the colostomy wound. At the second stage a transverse or paramedian incision is made, the patient put in the Trendelenburg position, and the small intestine and peritoneal cavity packed off with swabs or towels. The pelvic colon is secured and divided near the colostomy after being clamped, the ends are secured and invaginated by purse-string sutures, if this has all not been done previously. The lower end is seized and the bowel stripped up, the peritoneum being divided on either side close to it; glands are removed with the colon, and the sigmoid and superior hæmorrhoidal vessels secured. Care must be taken not to damage the left ureter. The dissection is carried down into the pelvis and the rectum freed as far as possible.

If the patient is ill or feeble, and the growth high in the rectum, this may be sufficient to permit of its removal, when if only an abdominal operation is being done, the bowel is clamped and divided two inches below the carcinoma, and the end of the lower portion invaginated into the bowel. The rectal stump thus remains like an inverted test tube, draining via the anus. The peritoneum is now sutured above this to re-establish the pelvic floor, the swabs are removed, the peritoneum closed, and the abdominal wound sutured, the patient meanwhile being returned *gradually* to the horizontal position so as to avoid the shock of its sudden resumption.

If it is desired to perform the abdomino-perineal operation, then the freed bowel is pushed down into the sacral hollow, and the peritoneum of the pelvic floor closed over it. The swabs are removed and the abdominal parietes sutured, the patient being returned slowly to the horizontal position meanwhile, so as to avoid the shock so often seen if that position is suddenly resumed.

The patient is then placed in the lithotomy or lateral prone position and a perineal resection rapidly carried out, the anus being first sutured. The cavity is plugged and treated as after perineal excision.

It must be impressed on doctor and patient that the abdomino-perineal is a severe operation involving considerable risk to life, and it should never be attempted except in healthy subjects, and usually in those not above fifty-five years of age. It must be emphasised again that none of these operations should be undertaken till at least ten days after a preliminary colostomy, and that this will remain permanently, except in those few cases of perineal excision where the anal sphincters and canal can be preserved and sutured to the upper end of the rectum. This fact should be impressed on the patient and the relatives *before* the first operation is performed.

The **perineo-abdominal operation** recently advocated, and claimed to have a smaller mortality than the abdomino-perineal, starts with the perineal part of the operation, the loosened rectum being subsequently removed through an abdominal incision in the same manner as described in the technique of the abdomino-perineal excision. This is certainly easier to perform.

(2) **Perineal excision** is the simplest method, but is suited only to papilliferous or early growths low down in the bowel, and the method does not permit of any adequate lymphatic removal. It is the operation of choice in epithelioma of the anus (p. 806), where the lymphatic area can be adequately removed.

FIG. 277. Advanced carcinoma of anus, involving the surrounding tissues.

(*a*) The patient is placed in the lithotomy or, better, the left lateral position, and the perineum, having been previously shaved, is purified and the anus stitched up. An incision is made along the natal cleft to one side of the anus if this is free of growth and can be preserved, or around it if the anus must be sacrificed, *i.e.*, if the sphincter needs removal, as is usually the case. The coccyx may need to be removed, and the bowel is then pulled on by the long ends of the anal suture, and freed by blunt dissection from the surrounding structures, bladder and urethra or vagina, care being taken especially to avoid damage to these and the ureters. The ischiorectal fat and as much perirectal fat as possible must be removed and the bowel drawn down as it is freed; the levatores ani and internal sphincter will be removed with the bowel, the former being divided as near the rectal insertion as is compatible with removal of the growth. In this way 3 or 4 inches of the bowel can be removed, and then if the anal sphincter is intact, the lower end is divided above this and the cut upper end freed of tension, drawn down and sutured to the anus. Where the sphincter is removed, no attempt need be made to draw down and suture the upper end of the bowel. The levatores ani should be sutured around the bowel and to its wall if the anus be preserved.

The cavity should be packed lightly with plugs of gauze soaked in paraffin, which need changing daily, when the patient has soaked them loose in a warm bath. If the anus is preserved, a tube may be inserted behind the bowel instead of plugging.

(*b*) A more elaborate operation on these lines, advocated by Lockhart Mummery, is to make the incisions as in the previous case and also remove the coccyx. The sphincters and levatores ani are then removed, the peritoneum opened at the bottom of the pouch of Douglas, and the pelvic colon drawn down, grasped and crushed. The bowel is cut across, and the ends are then invaginated with purse-string sutures, and the upper bowel-end has the peritoneum of the pouch of Douglas closely sutured to it about an inch above its lower end, to close the peritoneal cavity. The lower end is pulled down and the bowel excised, great care being taken not to open it, or peritonitis will result. The ureters, which together with the bladder are carefully protected in the earlier stages of the operation, require to be safeguarded here also. The peritoneum is then closed, and also the skin ; the wound must be drained, for it cannot heal per primam.

Morphia may be given freely for pain and shock, and if necessary a catheter may be passed, as retention of urine is common ; this is often relieved by a hot bath, as in all rectal operations.

(3) **Kraske's Sacral Excision.** Kraske's operation is very seldom performed nowadays.

Radium Treatment. Radium is used in cancer of the rectum by exposing the growth by means of an " operation of access." The coccyx and lower part of the sacrum are removed and the rectum, exposed in this manner, is surrounded with needles and tubes placed to control the lymphatic drainage in the cellular tissue and pelvic nodes. By this method disappearance of the primary growth has been obtained, and in our opinion it is the best method known at present for treating cancer of the rectum by radium. The results are usually however disappointing.

Two months after, when it is possible to do so, the rectum has to be excised, as islets of cancer cells always remain.

2. **Sarcoma of the rectum** usually starts in the submucous tissue and is extremely rare ; it is often a fibrosarcoma. When present it presents as a rapidly infiltrating, spongy red mass, which soon ulcerates and bleeds freely. Surrounding tissues soon become infected. The symptoms are similar to those of carcinoma, but the course is much more rapid and treatment by excision is seldom feasible. Colostomy is usually required, as the mass grows into the bowel and causes obstruction.

3. **Carcinoma of the anus** is always of the squamous-celled type, and, like that of the lip at the upper end of the alimentary canal, usually starts at the mucocutaneous junction either as a wart or an indurated fissure.

The warty variety forms an indurated mass in and around the anal margin, with a typical malignant ulcer at its centre ; this variety of growth often occurs at the side of the anus. The ulcerative type usually occurs in front or behind and spreads inwards as a series of ulcerated fissures, with the early formation of a fæcal fistula.

In both varieties the lymphatic infection is early, and it must be remembered that the anus drains to the *inner inguinal group of nodes,* which will be hard and fixed probably in both groins ; it cannot be urged too strongly that any enlargement of the inner inguinal lymph nodes makes a careful examination of the anus and perineum imperative.

There is often a serous discharge which dries and causes pruritus, and the induration and distortion of the anus are reflected in the fæces, which become thinned and irregular. The carcinoma spreads slowly.

Diagnosis is usually obvious, but occasionally tuberculous or syphilitic lesions may give rise to error ; in old women kraurosis vulvæ may spread back, and on a superficial examination be mistaken for epithelioma of anus, as also may carcinoma vulvæ.

Treatment. This consists in excision, together with removal of the inguinal lymph nodes. The raw area must be left to granulate, and should the sphincters need removal, colostomy should be performed as a preliminary operation. Radium gives good results in these cases.

CHAPTER XX

THE KIDNEY, URETER AND BLADDER

Surgical Anatomy of the Kidney and Ureter. The kidneys are essentially retroperitoneal organs, lying behind the peritoneum and being surrounded by a mass of fat of a somewhat specialised type. They reach roughly from the eleventh rib above to a considerable distance below the twelfth rib, lying opposite to the twelfth dorsal and first three lumbar vertebræ, while the presence of the liver causes the right kidney to be lower than the left. The lower ends of the kidneys are slightly further from the spine than the upper ends, while the spine of the first lumbar vertebra roughly corresponds to the hilum. With reference to the standard mid-Poupart plane, this passes considerably to the outer side of the middle line of each kidney. Behind, the kidneys lie upon the quadratus lumborum, the psoas, a portion of the diaphragm, and a small part of the aponeurosis of the transversus abdominis; the twelfth dorsal, ilioinguinal, and iliohypogastric nerves are in relation with their posterior surface.

The kidney may be regarded as having three capsules: its own *true capsule*, which is fibrous, thin, and strips off it readily; outside this is the *fatty capsule*, consisting of a somewhat specialised, loose, perirenal fat, which is easily infected; while this perirenal fat is enclosed in the *perirenal fascia* of Zuckerkandl, which fuses with the corresponding fascia on the opposite side of the spine and lies immediately behind the peritoneum. The *suprarenal body*, which lies immediately on the top of the kidney, is not, however, closely attached to it, being enclosed in a separate compartment of this fascia. Thus, if the kidney is displaced or drawn up into a wound by the surgeon, the suprarenal body does not come with it.

It must not be forgotten that the pleura is in relation with a portion of the posterior surface of the upper pole of each kidney, this portion depending upon the position of the kidney and the length of the last rib. At the kidney hilum the pelvis and ureter lie at the back, the artery in the middle, and the vein in front, while the lymphatics, which are very few in number, pass from there to the glands round the aorta. In the kidney there is a fairly definite arrangement of the blood vessels in two planes, so that if the kidney is split open along a line slightly posterior to its mid-vertical plane a minimum amount of hæmorrhage will occur; this is important in connection with exploration of the kidney.

Renal Pain. Pain in connection with renal disease may be of three kinds:—

(*a*) *True Renal Pain.* This probably does not arise in the renal substance itself, but is due to stretching, injury or other insult to either the pelvis or capsule of the kidney. The patient feels it in the loin and back immediately below the last rib, and also to a certain extent in the front of the abdomen immediately below the costal margin. These two varieties are sometimes described as posterior and anterior renal pain respectively.

(*b*) *Renal Colic.* This is probably due to violent contractions of the renal pelvis when stimulated by the presence of unaccustomed material, so that it makes an effort to expel it. In many cases so-called renal colic is really originating in the ureter. Its nature will be described later (see p. 836).

(*c*) *Referred Pain.* Though both renal and ureteric pain have a tendency to be referred down into the groin, testicle, labium and thigh, in some instances referred pain occurs actually due to involvement of the twelfth dorsal and first and second lumbar nerves in the renal lesion, for these nerves run down behind and in close proximity to the kidney.

Important points in connection with renal pain are: (*a*) its relation to rest and movement; (*b*) its situation and radiation; (*c*) its relation to micturition.

The Ureter. This descends almost vertically upon the psoas muscle, crosses the brim of the pelvis at the bifurcation of the common iliac artery, and runs round the outer wall of the pelvis to the base of the bladder. Its blood vessels run down with it, so that it may be dissected free from its surrounding attachments for some inches without risk. It should be remembered that the ureter is closely attached to the back of the peritoneum, so that in searching for it in the extraperitoneal tissues, when the peritoneum is lifted up the ureter will be lifted up with it and be found lying stuck to the back of the peritoneum, and not upon the retroperitoneal muscles.

Surgical Anatomy of the Bladder. This organ lies at a slightly different level in the infant and the adult, while it varies considerably according to the age and sex of the patient. In the infant the urethral opening is roughly at the same level as the upper border of the pubic symphysis, so that the whole of the front wall of the bladder lies in contact with the anterior abdominal wall above this. During the first few years of life the bladder and urethra gradually sink until in the adult the bladder lies entirely within the pelvis, unless it is very distended. When very distended it rises above the pubic symphysis, and may be felt here. The female bladder lies somewhat deeper still, and never rises so high above the symphysis. It is not so often palpable from the abdomen.

The *muscle* of which the bladder wall is composed consists of three layers of unstriped fibres, one circular layer and two longitudinal ones, while its *mucous membrane* is of the stratified or transitional type, being attached loosely to the bladder wall, so that it is thrown into folds when the bladder is more or less empty, and becomes smooth when the bladder is distended. At the base, however, there is a triangular area, known as the *trigone*, lying roughly horizontally, with its points formed by the openings of the urethra and two ureters, where the mucous membrane is always attached and smooth. The posterior side of this triangle, the triangle of Mercier, which is formed by a raised thickened band of muscle running between the two ureteric mouths, is known as the *interureteric bar*. It should be remembered that the trigone is always of a redder or pinker colour than the rest of the bladder, and is very sensitive.

The *peritoneum* covers the upper and back surfaces of the bladder, whence it passes on to the rectum or uterus and on leaving the latter forms the so-called pouch of Douglas. The front surface of the bladder is covered with peritoneum in its upper part, but the lower part lies in the cave of Retzius, close behind the pubic symphysis, and has no peritoneal covering. A considerable amount of loose fat lies between the bladder and the symphysis and abdominal wall. When the bladder becomes distended and rises up towards the abdomen, this anterior surface, bare of peritoneum, also comes up, so that a considerable area, 1 or 2 inches long or even more, of the front surface of the bladder becomes directly applied to the anterior abdominal wall without any peritoneum intervening. Through this area the distended bladder may be tapped or incised without opening the peritoneum.

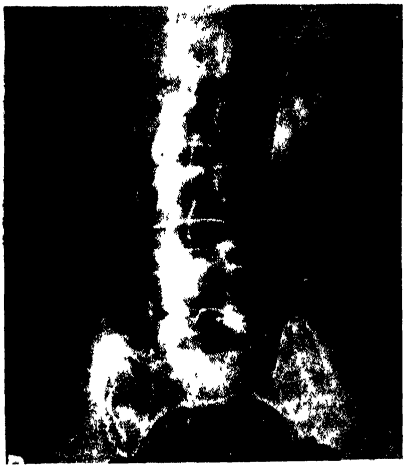
In the female the posterior surface of the bladder is in contact with the lower part of the uterus and the upper part of the vagina, without any peritoneum intervening.

There are three openings in the bladder wall: that of the urethra, at the apex of the trigone, is surrounded by a thin layer of involuntary muscle fibre, the *sphincter vesicæ*. This opening lies closely applied to the back of the prostate, so that if this gland becomes enlarged and projects into the bladder, it may insert itself within this sphincter and put the muscle out of action. In addition to this there are two voluntary muscles surrounding the urethra, the *compressor urethræ* and the *bulbocavernosus*, which also prevent the urine flowing from the bladder.

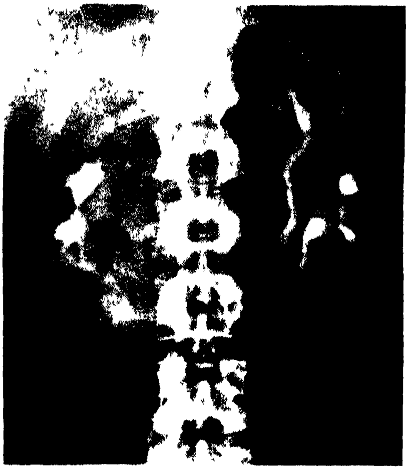
The ureters pass through the bladder wall obliquely for about three-quarters of an inch to reach their openings. The contraction of the bladder musculature during micturition thus effectually prevents urine being forced back up the ureters.

From the apex of the bladder the urachus, or obliterated remnant of the allantois, passes up towards the umbilicus.

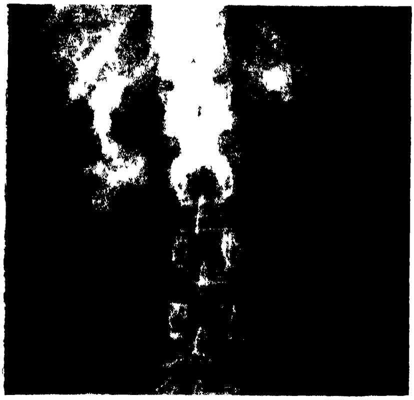
The *nervous control of the bladder* takes place through the lower lumbar and upper sacral segments of the cord. The process of micturition is partly reflex and partly voluntary, the stretching of the bladder when a certain amount of urine has collected giving rise to uneasy symptoms and starting slow contractions of the musculature. In time these, aided by voluntary contractions of the abdominal muscles, overcome the tonic contraction of the sphincter, and the urine commences to flow. It is thought that the trigonal muscle pulls back the posterior lip of the urethral meatus so that a few drops of urine trickle into the urethra and act as a trigger which starts the mechanism which inhibits the sphincter and makes the bladder contract. After that the remainder of the process is almost entirely automatic, though it can be voluntarily stopped and restarted again if desired. This complicated reflex will be obviously interfered with if the lumbar segments of the cord are damaged or if the voluntary



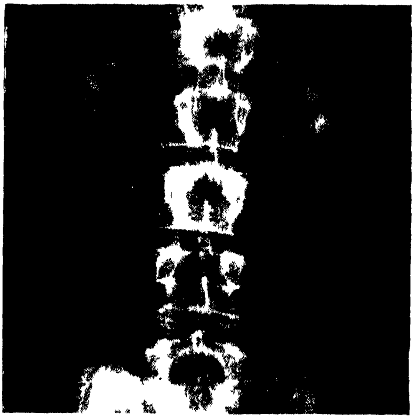
Renal calculus (left) with ureteric catheters in position to show contact with the stone in the dilated renal pelvis.



Pyelogram. Renal calyces normal. Double ureter on the left side.



Pyelogram. Left kidney normal. Slight dilatation of the right renal pelvis.



Pyelogram. Hydronephroses of right and left kidneys.

controlling fibres running down in the cord from above are destroyed, while peripheral impulses reaching the lumbar cord will interfere greatly with it. This is seen especially after operations on the rectum, perineum and lower abdomen, where the interference usually takes the form of inability to micturate, and also in emotional and hysterical states, where the interference usually takes the form of frequency or incontinence. The mucous membrane of the greater part of the bladder is not particularly sensitive to painful stimuli unless it is inflamed. That of the base, trigone and neck, however, is much more sensitive.

The vesical arteries provide the bladder with a free blood supply, while its lymphatics pass in the submucous layer back towards the glands in the hollow of the sacrum.

METHODS OF EXAMINATION OF THE URINARY TRACT

Disease of any portion of the urinary tract is so prone to affect almost the whole length of the tract that in all cases a complete examination of the bladder and kidneys will be necessary, even though the lesion appears to be confined to one or other of these parts. The ordinary methods of inspection, palpation and percussion are first employed. It must be remembered also that a complete examination of the patient's other systems is of great importance and may shed much light on the urinary condition.

(1) **Palpation.** *The kidney* is palpated with the patient lying on his back, his head raised and his thighs flexed. Standing on the right side, one hand is placed behind in the loin and the other presses over the kidney region immediately below the costal margin, while the patient is instructed to breathe deeply in and out. It is probable that by this means a perfectly normal kidney cannot be felt except in very thin people, but if the kidney is enlarged, low, or abnormally mobile, it can be palpated easily. Its size, outline and consistency can be examined while it can be felt to move freely up and down with respiration. Under an anæsthetic this palpation is even easier. In many cases great enlargement of the kidney is present, giving rise to what is known as a **renal swelling or tumour.** The characteristics of this swelling which distinguish it from a splenic or other tumour are :—

(*a*) That it can be palpated and moved between two hands, one in front and the other behind, and its shape is usually roughly ovoid, without edges or notches.

(*b*) That it bulges right out into the flank and a hand cannot be pressed into the abdomen behind it.

(*c*) As it enlarges it spreads directly across the abdomen and out into the flank, and not down towards the umbilicus as does a splenic tumour.

(*d*) There is nearly always a band of resonance across the front of it owing to the colon crossing it, while the flank is always dull on percussion from the fact that the colon cannot get behind the swelling. Renal swellings move up and down on respiration unless large or fixed, but they move less than do hepatic or splenic swellings, while a band of resonance is present nearly always on the right side between the tumour and the liver.

(*e*) The swelling can be reduced into the loin.

A *splenic swelling* feels as though it were just beneath the abdominal wall, has a characteristic shape, reaches down towards the umbilicus, is dull on percussion, and has a notch on its anterior border (see p. 771).

Large renal swellings are clearly visible on inspection of the abdomen, while percussion will give valuable information as to the relative situations of the tumour, colon, stomach and small intestine. Further special tests may be applied to see whether such a swelling is of renal origin or not (see p. 810, Pyelography).

The bladder can be palpated only if distended or displaced, when it may be felt rising above the pubes as a firm, fixed, rounded, cystic tumour, dull on percussion and often rather tender on pressure. The distended bladder is very easily felt with one finger in the rectum and the other hand on the abdomen. The possibility of a distended bladder should be remembered in the case of every swelling of the lower abdomen. Such a swelling of course disappears if a catheter is passed.

When the rectum is examined in the male the prostate with its median groove and two lobes, the base of the bladder above it and the seminal vesicles on either side can be palpated, especially if the bladder is full. In children vesical calculi may be felt in this way, and in the female similar information is obtained by a vaginal examination, while a thickened ureter can sometimes be felt. Grossly distended bladders are often encountered which can be seen and felt above the symphysis reaching to the umbilicus. Such a swelling is dull to percussion and immovable, while the passage of a catheter will cause it to disappear rapidly.

(2) **X-ray examination** of the kidney, ureters and bladder is of the greatest importance. Stones and foreign bodies will be detected thus in any of these organs, and calcification of the kidney substance is sometimes noticed. A good X-ray film will demonstrate the outline of the kidney tissue, whether normal or diseased, while the psoas muscle should also be visible. In addition to this, X-ray examination plays an important part in such methods as pyelography and the passage of ureteric bougies (see below). The technique is described below and in Vol. I., Ch. XXIII.

A *cystogram* or X-ray picture of the bladder may be obtained also by filling it with an opaque fluid such as sodium iodide solution (see below).

(3) **Cystoscopy.** This is by far the most important and most valuable method of examination of the urinary tract, the cystoscope being an instrument which is passed up the urethra and by means of which not only can a direct view of the inside of the bladder be obtained but certain other exceedingly important intravesical manipulations can be performed. It is not usually necessary to give a general anæsthetic, a small amount of a solution of 1 or 2 per cent. novocaine being injected up the urethra five minutes before. The instrument is then lubricated and passed and the bladder emptied and washed out through it until the water returning is quite colourless; 10 to 12 ounces of clear water are then left in the bladder, the light is switched on and the inspection made. The whole of the bladder wall is examined, every part of it being visible except that very close to the urethra or behind an enlarged prostate. The colour of the wall of the normal bladder is yellowish or cream, this becoming pinker or redder as the base of the trigone is reached. Ulcers, cystitis, tubercles, growths, stones, the mouths of diverticula, trabeculation of the bladder wall, alteration in the shape or colour of the bladder, foreign bodies and enlargement of the prostate are at once detected, though experience is needed to interpret what is seen; cystoscopy by an inexperienced surgeon is often a snare and a delusion. The mouths of the ureters are seen and compared and changes in their shape and appearance noted. The urine can be seen coming down the ureters in gulps and drops every half-minute or so. Pus or blood in the urine can be at once detected, so that it can be ascertained for certain whether they are coming from the bladder or from which kidney. Any marked changes or alterations in the mouth of one ureter are very strong evidence of disease in that ureter or kidney, and with experience the nature of a diseased kidney often can be ascertained almost for certain by the appearance of its ureteric mouth.

In addition to the direct vision of the bladder obtained by this instrument, it is employed in several other useful diagnostic methods. By its means small *ureteric catheters* are passed up each ureter to the pelvis of the kidney, also without an anæsthetic. If hollow these catheters are then left in for a certain period so that the urine from each kidney is collected separately for examination. The passage of the catheter up the ureter will be hindered by kinks, strictures, stones and other forms of ureteric obstruction. Moreover, a *catheter or bougie which is opaque to X-rays* may be employed and passed up to the kidney pelvis. The photograph taken with the bougie in situ will show the exact line of the ureter and position of the kidney, so that any shadow seen may be compared in position with the shadow of the catheter, and this will make certain whether such a shadow is a stone or not; for it must be remembered that shadows seen in X-ray film are frequently not due to stones in the kidney, bladder or ureter. They often are due to phleboliths, calcified glands or fibroids, calcareous deposits in other tissues, fæcal matter, appendix concretions, fæcoliths or gall-stones. Stereoscopic pictures are especially valuable in this connection. If there is a stone impacted in the ureter sterile paraffin may be injected to help it pass down.

In addition a *pyelogram* may be made.

(i) *Ascending Pyelogram.* To do this, by means of a hollow ureteric catheter, the pelvis of the kidney is distended with a fluid opaque to X-rays, 13 per cent. sodium iodide solution being the best. A photograph then taken will demonstrate the shape, size and position of the kidney pelvis, while the amount of fluid that flows in also will demonstrate its size and content. The fluid must be run in up a very small catheter, under a pressure of only about 8 or 10 inches of water, and the patient should not be anæsthetised (see Vol. I., Ch. XXIII.). All fluid must be drained out through the catheter at the end.

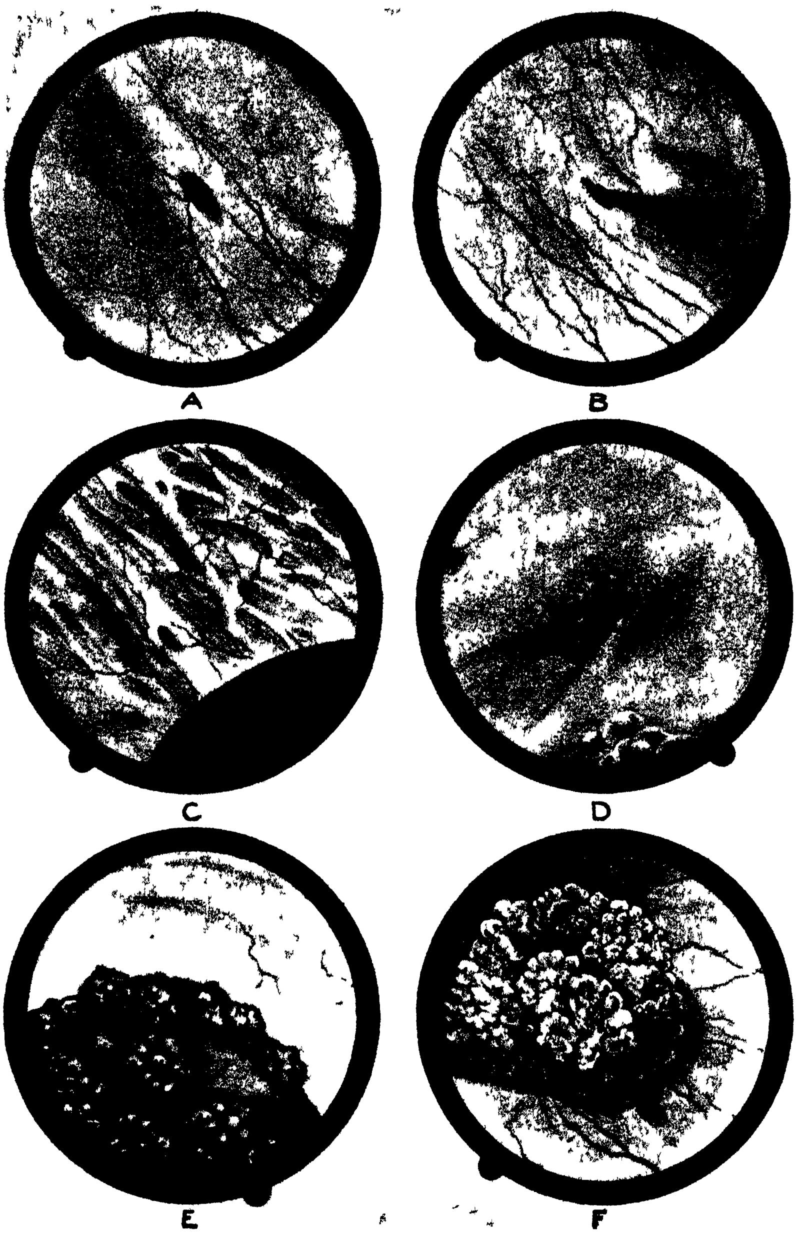


FIG 278. Cystoscopic views. (A) Normal right ureteric orifice. (B) Blood shooting from right ureteric orifice (C) Enlarged prostate (note trabeculated bladder). (D) Retracted (golf hole) left ureteric orifice in tuberculosis of the kidney, with tubercles of the bladder showing in the bottom of the field. (E) Oxalate calculus. (F) Papilloma situated above the right ureteric orifice.

(ii) *Descending Pyelogram.* In the last few years a method of making a double pyelogram without passing a ureteric catheter has been introduced (*intravenous pyelogram*). A chemical body, such as uroselectan or abrodil, which is secreted in the urine and is then opaque to X-rays, is introduced into the blood. The bowel is cleared of gas, and the bladder emptied, and the pelvis and legs are raised. 40 grs. of uroselectan in 100 c.c. of sterile saline (or even a little more) or 20 grs. of abrodil are introduced intravenously, very slowly, and X-ray photographs are taken of both kidneys, a quarter, half, three-quarters and one and a quarter hours afterwards—the second picture usually being the best. The outline of the pelves and ureters should be seen, though the pictures often are not as definite as pyelograms done with a ureteric catheter. The results are best if a definite obstruction is present in the ureter concerned.

Uroselectan may also be useful as a test of the renal function, for if the kidney efficiency is impaired its appearance in the urine is delayed in some cases, but it cannot be relied on as normal kidneys will often show delay in secretion, while grossly diseased ones may secrete rapidly. Almost all of it can be recovered from the urine and with normal kidneys it should all be eliminated in about eight hours. If the function is poor this elimination will be much delayed. Recently a more concentrated solution, *Uroselectan B*, has been employed with success—only half the amount being injected. All of these solutions are very irritating if allowed to escape from a vein into the tissues.

In addition to the above methods, small forceps, scissors, dilators, electrodes for diathermy and radium applicators, can all be introduced up the cystoscope and used in the bladder under direct vision. When the examination is finished the light is turned off and allowed to cool for a short time, the water is run out through the cystoscope, and the instrument is withdrawn. Small-sized instruments are available for male children.

An old-fashioned instrument, known as a *separator*, used to be introduced into the bladder in an attempt to collect the urine from the two kidneys separately. This is difficult to use and inefficient in its results, so that it has been replaced entirely in modern practice by passing a catheter up each ureter and collecting the urine separately from each kidney.

(4) Occasionally, examination of the bladder by means of a *bladder sound* is useful, as by this means stones may be felt and heard to clink when struck by the sound; naturally this method has been almost altogether superseded by cystoscopy. Occasionally tumours and growths of the mucous membrane may be felt in this way. The base of the bladder can always be examined from the rectum, and it is sometimes advantageous to examine the rectum with the sound in situ, as by this means further information may be obtained.

In the female the bladder may be inspected directly up the urethra and the ureter catheterised by means of Kelly's speculum. Cystoscopy is, however, infinitely preferable.

(5) It is often advisable, after the patient has passed as much water as he can, to pass a catheter into the bladder and draw off any urine that remains. This "*residual urine*" should be measured, as its amount may be important, for it bears a very definite relation to the amount of loss of kidney function and therefore to the extent of the disease. More than four ounces of residual urine should be regarded as serious.

(6) **Examination of the Urine.** This is naturally of the greatest importance and must include a complete chemical, microscopical and bacteriological investigation. Various terms are employed in connection with abnormal conditions of the urine, most of which explain themselves. Thus *albuminuria, hæmaturia, glycosuria, pyuria*, are self-explanatory, the former of these conditions being by far the commoner. *Polyuria* and *oliguria* denote increase or diminution of the amount of urine passed, *anuria* being total arrest of urinary secretion, while *bacteriuria*, in which the urine is rendered cloudy by enormous numbers of bacteria without there actually being any pus cells present, is not uncommon. It must be remembered that in the female contamination by vaginal and vulval secretions may give rise to a false albuminuria.

(*a*) **The Surgical Significance of Albuminuria.** Apart from diseases of the urinary system, the urine must be examined in every case before an operation, and not uncommonly albumen will be found in it. With regard to diseases of the urinary tract itself almost every lesion may give rise to the condition; thus it may be found in infection of the kidneys and bladder of all kinds, in growths, stones, stricture, enlargement of the prostate, etc., while apart from the purely surgical conditions, chronic Bright's disease may be the cause of it. In other instances, old-standing suppuration may have been present, and in this case the albuminuria is probably evidence of lardaceous disease. In some cases it is of an intermittent functional type and is not evidence of any organic renal lesion. Cardiac disease also will give rise to albuminuria owing to the back pressure upon the kidneys.

When dealing with surgical diseases of the urinary tract the question of albuminuria is naturally wrapped up in that of the total renal efficiency, to be discussed later. But when before a projected operation on some other part of the body albuminuria is found to be present, which is thought to be due to any of the other causes, it may influence greatly the magnitude and even the possibility of the operation (with the exception of the functional or intermittent type). Thus, if Bright's disease is definitely present, operations of pure convenience should not be performed, especially if signs of high blood pressure, thickened arteries and poor kidney efficiency are present, while if an operation becomes suddenly necessary for a grave surgical emergency, it should be of the smallest possible type and be performed as quickly as possible. For in patients of this type healing is uncertain, infection and suppuration likely to occur, hæmorrhage is quite possible and anæsthesia is difficult.

Rarely cases are seen in children where albuminuria occurs, symptomless except possibly for constipation, and on investigation it is found to come from the left kidney alone. The left kidney is usually enlarged and the condition is due to pressure on the left renal vein by the superior mesenteric artery.

(*b*) The presence of **glycosuria,** due to true diabetes, also absolutely contraindicates any operation of convenience, but it must be remembered that in many instances only a simple glycosuria is present, and this is no bar to surgical treatment. Certain surgical conditions, such as grangrene, carbuncle, abscesses, cellulitis and boils, give rise to a glycosuria which may be regarded as one of their symptoms. Its origin is uncertain. Operations performed upon patients who suffer from true diabetes are liable to be followed by poor healing, infection and suppuration and the onset of diabetic coma, but all these complications are rendered much less likely by a previous course of insulin.

(*c*) **Hæmaturia** occurs in a variety of lesions of the urinary tract, such as stone, tuberculosis and other infections, growths, enlargement of prostate, etc., while many other general and medical conditions also may give rise to it, such as acute or chronic nephritis, cardiac disease and various blood diseases. Steps must be taken always to ascertain exactly where blood in the urine is coming from, and this can be done by means of the cystoscope, for by this instrument it can be seen at once whether the blood is coming from the bladder or from one or both ureters. It must not be forgotten that in women contamination may occur from the menstrual flow.

(1) *Hæmorrhage from the urethra* escapes independently of micturition or when micturition occurs and is always confined to the first few drops passed. It consists of bright blood hardly at all mixed with the urine, and may be due to injury, such as ruptured urethra or catheterisation, acute urethritis, impacted calculus, etc.

(2) When it comes from *the prostate* it may occur independently of micturition, but more often is mixed incompletely with the urine, which is usually of a dark red or wine colour and sometimes appears to be almost pure blood. Prostatic hæmorrhage is the result of injury, acute prostatitis, simple or malignant enlargement and prostatic calculus.

(3) *Hæmorrhage from the bladder* is common and the cystoscope will demonstrate where it is coming from. It may be the result of injury, cystitis, acute, chronic or tuberculous, growths, calculus, ulceration or of bilharzia. The urine and blood are intimately mixed and are of a port-wine colour, though rather more blood comes at the end of micturition. Large clots are often present.

(4) *Hæmorrhage from the ureter* is very rare, though occasionally acute appendicitis gives rise to sufficient congestion to cause it. It has the same characteristics as renal hæmaturia (see below).

(5) *Renal hæmaturia* is common, and the cystoscope will demonstrate at once from which kidney it is coming. The blood is mixed with the urine, which is not often deeply coloured, but more commonly is brown or smoky. Long, thin, worm-like clots, owing to the shape of the ureter, are often present, while renal casts will be discovered frequently also. Hæmorrhage may occur in almost every disease of the kidneys, being especially common in tubercle, injuries, growths and calculus.

(6) *Hæmaturia due to general diseases,* as described above, almost invariably comes from the kidneys and from both kidneys, when the cystoscope will demonstrate the blood passing down both ureters.

It must be remembered that certain cases of apparent hæmaturia are really *hæmoglobinuria,* microscopic examination showing that no red cells are present. This condition (paroxysmal hæmoglobinuria) is sometimes seen in Raynaud's disease.

(*d*) **Pyuria** requires the same type of investigation to ascertain its origin as does hæmaturia. It is always evidence of inflammatory conditions of the urinary tract. Chyle is occasionally found in the urine.

(*e*) Various kinds of **solid urinary deposits** are often present and may be identified either by their microscopical appearances, their crystalline structure, or their chemical reactions. The reader should refer to books on pathological and clinical chemistry for a full discussion of these.

The chief of these deposits are uric acid, urates, oxalates of lime, and phosphates. An excess of the former in the urine is associated with the so-called uric acid diathesis and is sometimes known as **lithiasis**. It is a purely medical condition, of which the treatment consists in diet and general hygiene.

Excess of oxalate of lime in the urine is known as **oxaluria** ; this has an important surgical bearing and will be discussed on p. 839.

An excess of phosphatic deposits is by no means uncommon and is responsible for the formation of many calculi. A curious condition known as **phosphaturia** is sometimes seen in hypochondriacal people, especially after periods of nervous anxiety or sexual excitement, when there is an enormous excess of phosphates in the urine. The urine becomes cloudy and opalescent, the patient feels seedy, depressed and unwell, and has vague pains in the lower part of the back and thighs. Frequency also may be present. The condition usually clears up on the administration of large doses of acid sodium phosphate.

The deposits found in acid urine consist of urates, uric acid and oxalates ; those in alkaline urine are phosphates.

(*f*) The *bacteriological examination* of the urine is of the greatest importance, and in many cases will settle the diagnosis. For cultural purposes a sterile specimen of urine, of course, must first be obtained. In the male this may be done by carefully cleaning the end of the penis with antiseptics and allowing the water to be passed into a sterile receptacle. In the female, however, it must be obtained by means of a catheter. To examine urine for the tubercle bacillus a sterile specimen is not required, but as the bacillus may only be passed intermittently, the whole twenty-four hours' urine must be collected and a sample of this be examined.

(*g*) In connection with certain lesions of the bladder and lower urinary tract, it may be of value to watch the patient passing water in order to note the shape of the stream and his ease or difficulty in passing it, etc.

A *two-glass test* also may be of value, the first portion of the urine being passed into one glass and the rest into another, as this will give an indication as to which part of the urinary tract threads or pus are coming from.

The Care and Sterilisation of Urinary Instruments. *Catheters* may be made of rubber, metal, glass, or gum elastic, and it is preferable to use the softer ones if possible. Rubber, glass and metal instruments may be sterilised by boiling, while gum elastic instruments should be placed for a quarter of an hour in 1/1,000 biniodide or perchloride of mercury. Modern gum elastic catheters can be boiled for a short time provided they are enclosed in a thin bag so that they do not touch the metal of the steriliser. They should be lubricated either with glycerine or sterile paraffin. Sterile vaseline in a collapsible tube is useful for carrying about.

Ureteric catheters can be sterilised by formalin vapour, by 1 in 1,000 biniodide or perchloride of mercury or by boiling for a short time in a bag. They are lubricated by glycerine or sterile paraffin.

A cystoscope must not be heated but can be sterilised either by immersion in absolute alcohol or methylated spirit for a quarter of an hour or by means of formalin vapour. It is best lubricated with glycerine, as paraffin is liable to form drops upon the lens which interfere with visibility.

The Renal Function. In connection with the surgery of the whole urinary system, including that of the kidney, ureter, bladder, prostate and urethra, a guiding factor which is of supreme importance is a consideration of the efficiency of the kidneys in performing their excretory work ; for not only does back pressure of urine and disease anywhere in the urinary tract in many cases cause this renal function to deteriorate, but if the kidneys are already damaged and their efficiency below par, the performance of any operation upon the urinary tract is likely suddenly to precipitate a very marked failure of renal function, which, though it may be only temporary, is often sufficient to carry the patient off. In every case of disease of the urinary tract, therefore, we have to consider the total functional efficiency of the two kidneys. In the surgery of the lower urinary tract, *i.e.*, the bladder, prostate and urethra, we are concerned chiefly with the two kidneys together; but when dealing with lesions of the upper urinary tract, *i.e.*, the kidney and ureter, we have, in addition, to consider the renal efficiency of each kidney separately. For in the latter conditions we are always faced with the possibility of having to remove one kidney, and before this can be contemplated it is essential to find out:

(*a*) Whether the other kidney is present;

(*b*) Whether its efficiency is sufficient to carry on all the urinary secretion if the diseased kidney is removed; and

(*c*) What the efficiency of the diseased kidney is, so that we may have an estimate of the value of the renal tissue of which we shall be depriving the patient if that kidney is removed.

This will entail collecting the urines of the two kidneys separately.

Many different tests for estimating the efficiency of the renal function have from time to time been devised. Here, however, we can give only a short account of them.

If it is desired to know the total efficiency of the two kidneys together, cystoscopy is not necessary and any required tests may be performed upon the mixed urine which the patient passes. When, however, the separate efficiency of the two individual kidneys is required, cystoscopy and ureteric catheterisation are performed, the urine from the two kidneys is collected separately and similar tests are applied to the two separated urines. Though actual collection of urine with the ureteric catheter from the second kidney is the only certain method of testing its efficiency, information may also be obtained about it by noting with the cystoscope the state of its ureteric mouth, and whether urine can be seen emerging from it, while during an operation the kidney in question may be palpated with the hand or even inspected with the eye in order to ascertain whether it is present and what its condition is, as disasters have occurred in the past through surgeons removing the kidney when only one is present.

The older tests of the renal function consisted very largely in the injection into the body of certain coloured dyes which were excreted into the urine in visible form, an estimation then being made of the amount of the dye which came through and the rate at which it was excreted. Thus methylene blue was employed with this object in view, as also was phenol-sulphone-phthaline. Indigo-carmine also has been employed, while phloridzin was used at one time as it has the effect of making sugar appear in the urine of a healthy person in about fifteen minutes. Estimation of the total urea passed in twenty-four hours was also of value.

These coloured dye tests, however, have been replaced almost entirely by the more modern methods of chemical examination of the urine and blood with a comparison of their content of certain important substances, such as urea. This is a standard test always performed now, and it depends upon two estimations:

(*a*) The total urea content of the blood;

(*b*) The concentration of urea in the urine passed during the first three hours after 15 grammes of urea have been taken by the mouth, especially that passed during the second hour.

Thus in a case when we know for certain that a lesion of one kidney is present, it is still possible for the blood urea content to be normal owing to the activity of the other kidney—in fact, if one kidney is out of action completely, or has been removed, the second kidney if normal still will keep the blood urea content down to normal. The normal blood urea content is 0·02–0·04 per cent. On the other hand, if we have for certain a lesion of one kidney and the blood urea content is 0·05 per cent. or above that, we can be certain that the other kidney is affected.

Secondly, if the blood urea content is normal we can obtain the relative efficiencies of the two kidneys by estimating the urea concentration of the urine collected from the kidneys separately by ureteric catheters. Fifteen grammes of urea is given by the mouth, and the urines are collected during the second hour after administration. A perfectly sound kidney should give a concentration of from 2·5 per cent. upwards.

The blood urea content is always a more valuable test than the urine urea concentration one, but a combination of the two is the most reliable.

In the case of an enlarged prostate we are concerned with the two kidneys together, and here again the blood urea-content is the more valuable test. The question as to whether a prostate should be removed in a one-stage or two-stage operation will arise (see p. 925), and if the blood urea content is above 0·04 per cent. a two-stage operation is probably advisable, if it is above 0·05 per cent. it is certainly advisable.

But in this connection the amount of sepsis and infection in the bladder and urinary tract must be taken into account, for this may have a most evil effect. An ideal case for prostatectomy in one stage should have a blood urea content of 0·03 per cent. or less and a urine urea concentration greater than 3 per cent., if a three hours' test is performed, while the urine should be clean. If much residual urine is present, as in an enlarged prostate, this should be drawn off with a catheter before commencing a urine urea concentration test. If there is a high initial blood urea content, and operation is being therefore done in two stages, it is advisable to wait till the blood urea concentration has come down to 0·04 per cent. before doing the second stage.

An estimation of the blood-cholesterol is of value as indicating how serious an effect septic infection of the kidney may have had, for cholesterol is thought to stimulate the production of antibodies. The normal blood-cholesterol is from ·08 to ·23 per cent., and diminution of this may be regarded as some indication that renal infection is severe.

Other tests which are sometimes employed are the urea clearance test and the blood creatinine test.

It must be remembered that the performance of these tests is a skilled and abstruse chapter in chemistry, and that if they are to have any value at all they must be undertaken by an expert.

An indication of the state of the kidney function is also given clinically by such signs of renal failure as thirst, loss of appetite, a brown furred tongue, headaches, pallor and anæmia, constipation, and lowering of the specific gravity of the urine.

A kidney function which is under 30 per cent. of the normal is definitely a bad surgical risk.

Anuria is the condition in which the kidneys entirely cease secreting urine so that none flows into the bladder (suppression of the urine). It must be carefully distinguished from acute retention of urine in which urine is formed but cannot flow out of the bladder. Anuria may be grouped from the causative standpoint under the four main headings :—

(1) Circulatory, due to low blood pressure.

(2) Reflex, as a result of conditions in the opposite kidney or elsewhere in the urinary tract. This type of anuria is sometimes seen in spinal anæsthesia.

(3) Infective, as is seen in double surgical kidneys.

(4) Obstructive, as a result of back pressure in the kidney.

These will be dealt with subsequently.

Uræmia. As uræmia is the end result which causes death in so many conditions of the urinary tract and is a condition always present in the mind of the surgeon when kidney or bladder operations are under consideration, it is not out of place to discuss it shortly here. It must be remembered also that it not infrequently arises after surgical procedures in no way connected with the urinary tract, and that its very symptoms in some cases may resemble those of truly surgical lesions, such as acute obstruction (see pp. 678 and 727). The condition is due to a failure of the renal function, so that toxic products accumulate in the blood and poison the patient. The anuria to which this gives rise (suppression) must be distinguished carefully from retention. The condition may come on gradually or quite suddenly, while any of the following group of symptoms and signs will be seen : headache, vomiting, convulsions, fits and twitchings, a harsh dry skin, brown dry tongue, often cracked, and sometimes black (Parrot tongue), delirium, onset of coma, abdominal distension, a hard slow pulse, a hay-like scent in the breath, and finally death from cardiac failure. Curious paralyses and asthmatic attacks are sometimes seen, while a remarkable hissing type of respiration, due to œdema of the glottis, is not uncommon. Though in most cases the amount of urine is markedly diminished or even complete suppression may occur, it sometimes happens that the patient continues to pass extra large quantities of very watery urine of low specific gravity, and with very poor urea content. Delirium is often marked.

The *treatment* of this condition consists in removal of the cause, together with every possible step to promote the excretion of toxins. Thus the patient should be given large quantities of fluid if possible, and watery purges in the form of jalap, etc., should be administered, while every effort should be made to induce him to sweat by means of hot packs, hot air baths and even the administration of pilocarpine hypodermically. This latter drug is, however, not always free from risk. Diuretics may be tried in the form of pituitary, digitalin and mercury pill, caffein citrate, and theocin-sodium-acetate, while the infusion of saline with bicarbonate in it or of small quantities of hypertonic saline is often valuable. For fits and convulsions chloroform may be necessary occasionally, while bleeding is sometimes employed for this condition.

Surgical procedures, such as decapsulation of the kidneys, are occasionally useful (see p. 834).

CONGENITAL CONDITIONS OF THE KIDNEY AND URETER

(A) **Complete Absence of One Kidney.** This luckily is very rare, but a rather more common condition is one which is equally serious, namely, a congenital atrophy or imperfect development of one kidney, where the organ is only represented by a mass of fibro-fatty tissue, though small renal vessels and an abortive ureter are present. In either case the other kidney is hypertrophied while the testicle on the same side may be imperfectly descended. The surgical effect is the same in each instance, for it constitutes a grave trap in the performance of a nephrectomy. There should be, however, no difficulty in discovering that only one kidney is present by means of cystoscopy and the renal tests described above.

The sound hypertrophied kidney is sometimes painful, and may then be mistaken for a growth or other pathological condition. It must be remembered that a solitary kidney occasionally has a double ureter and two openings in the bladder.

(B) **Lobulation of the kidney** is sometimes seen and is of no significance. This is a persistence of the fœtal condition which also occurs normally in certain animals.

(C) **Horse-Shoe Kidney.** In some instances the kidneys are rather nearer the midline than usual, and their lower ends are fused and meet across the vertebral column. This is said to occur roughly in 1 in 1,000 persons. Usually two ureters are present, which run down across the front of the lower end of the organ, but sometimes more than two are present. Either half of a horse-shoe kidney may become involved by disease, while the condition sometimes gives rise to an ill-defined palpable abdominal tumour. Its chief importance lies in the fact that should an operation be necessary upon either kidney, grave difficulties will be encountered in bringing it up into the wound.

A more complete fusion of the kidneys sometimes occurs, known as a discoid kidney.

(D) **Accessory renal arteries** are occasionally present, which may give rise to hydronephrosis (see p. 821).

(E) **An extra kidney** is sometimes present, while **double ureters** on one side are by no means uncommon. A double ureter is sometimes accompanied by a double pelvis in the kidney. The two ureters sometimes run separately the whole way down to the bladder and enter it by two separate openings, while at times they meet half-way down. In this case there are no symptoms, but in other instances one ureter may have an abnormal opening into the prostatic urethra or even into the vagina. If this is so, dribbling of urine occurs from childhood, though this is not very marked, while the patient is also able to void urine at intervals in a perfectly normal manner. The condition requires no treatment unless the latter state of affairs is present. When this is so, an operation must be performed to transplant the supernumerary ureter into a fresh opening in the bladder.

(F) **Ureterocele.** Ballooning of the lower end of the ureter is sometimes seen, owing to a congenital stricture at its opening into the bladder. This is really a prolapse of the dilated lower end of the ureter into the bladder, consisting chiefly of mucous membrane. At times calculi have formed in this. Seen by the cystoscope, the appearance is that of a cyst at the lower end of the ureter, often with a nipple-like-projection on it, varying in size from a pea to a walnut. It may cause renal pain, frequency and hæmaturia. The treatment consists in incising the cyst and dilating the ureter with an operating cystoscope.

Certain deformities and abnormal origins of the ureter from the kidney pelvis occur, which may give rise to hydronephrosis (see p. 821).

Congenital Displacements of the Kidney. In a small percentage of individuals, one or both kidneys are found lying in abnormal situations, the left being the one more commonly affected. Thus the kidney may be displaced towards the middle line, may be found lying at a higher level than usual or more commonly is found abnormally low, in which case it probably lies in the iliac fossa on the brim of the pelvis or even right down in the pelvis. In this way the descending colon and rectum may be displaced. In these congenital cases the renal vessels also take an abnormal origin either from the aorta or from the iliac vessels, and this will distinguish the condition from the acquired variety (movable kidney). It must be remembered that in all abnormal positions of the kidney, whether acquired or congenital, the suprarenal bodies do not accompany the organ.

Such a displaced kidney, as a rule, gives rise to no symptoms unless it becomes diseased. It is sometimes detected as a palpable tumour and may give rise to difficulties in diagnosis, while an abnormally placed kidney is especially liable to infection and stone formation. If it is abnormally movable its pedicle may become twisted as in a movable kidney (see below).

Certain other conditions of the kidney which are sometimes congenital, such as sarcoma, hydronephrosis and congenital cystic kidney, will be described later.

Aneurysm of the Renal Artery. This is a rare condition, which is occasionally seen, most often on the right side and at times following an injury of the renal pedicle. It gives rise to a pulsating swelling in the renal region, with pain and occasional hæmaturia. The only treatment consists in nephrectomy with ligature of the renal artery. In this connection care must be taken not to mistake the pulsation of an aorta pushed forward by a scoliotic spine, for an aneurysm.

Movable Kidney, Floating Kidney (Nephroptosis). Though the normal kidney moves freely up and down on respiration, in many instances the organ is found to have a considerably greater degree of mobility than it should. Three stages of this condition are sometimes described :—

(*a*) One in which the lower pole or lower half of the kidney can be felt distinctly to move up and down on respiration. This is only just beyond the normal limits.

(*b*) One in which the kidney moves freely about behind the peritoneum, where its upper pole can be palpated and the kidney held down with the hand. This is known as a **movable kidney.**

(*c*) In a still more marked type the kidney moves forward and becomes provided as it were with a mesentery, due to elongation of the peritoneum, the perinephric fat and the renal vessels. It can then be moved freely about the abdomen in all directions. This is known as a **floating kidney.** Here again the suprarenal body does not accompany the kidney.

It will be seen that most of these movements occur within the perirenal bag of fat, though after a time, if attacks of inflammation occur, the fatty capsule may become attached to the kidney and move with it. The movements which occur are partly sliding up and down, partly to and fro, while not infrequently there is a remarkable element of twisting, on either a vertical or transverse axis, and this is liable to lead to pressure on or torsion of either the vessels or the ureter.

As a result of this condition secondary changes are liable to occur in the kidney, these being due chiefly to the rotatory element in its movements. The ureter is fixed to the back of the peritoneum and therefore moves less than the kidney, with the result that it is liable to intermittent obstructions. Thus after the condition has been present for some time hydronephrosis is liable to commence, while such a kidney is always abnormally liable to attacks of inflammation (pyelitis or pyonephritis), to injury, and to Dietl's crises.

It must not be forgotten that in many cases a movable kidney is only part of a general visceroptosis (see p. 655), and it therefore may be accompanied by the characteristic changes in other abdominal organs, but these are in no sense secondary to it.

It is possible, as a result of inflammation and irritation in the perirenal tissues, due to the mobility, that fibrosis may set in and the organ become fixed in either its normal or abnormal situation.

With regard to the cause two prominent facts stand out. Firstly, that the condition is about ten times as common in women as in men, and, secondly, that it is about fifteen times commoner on the right side than on the left, this latter fact probably being due to the longer right renal vessels and the downward pushing of the kidney by the liver. There probably is some congenital change in the kidney bed and the position of the renal vessels in many cases, while its fascial capsule may be developed imperfectly. A kidney is normally more or less fixed by the firm fat surrounding it, the intra-abdominal pressure and the general musculature of the body, and it is therefore to changes in these conditions that we should look in searching for a cause; thus rapid emaciation and loss of fat, pregnancies, or rather the parturition which follows, lack of abdominal tone, and removal of large abdominal tumours are all probable causes. It was at one time thought that badly designed female clothing, such as tight or improperly fitting corsets and waist belts, was responsible for it, but there is probably little in this, for the condition is still commonly seen among the more enlightened and uncorseted females of to-day. It may be that some cases are definitely produced by injuries, single or repeated, such as falls, lifting weights, or gymnastics. Constipation is frequently present, and though it is possible that an overloaded cæcum might produce the condition by dragging upon the peritoneum and kidney, we regard this as more likely to be the effect of the accompanying visceroptosis and not the cause. There is a distinct tendency for the condition to run in families, while it is especially seen in people with long, thin chests and broad, shallow loins. In a few instances the dragging of the kidney will pull upon, and even partially obstruct, the bile-duct or duodenum.

Clinical Features. The condition is most commonly seen in women under forty, especially those who are thin and tall; rarely it is bilateral. In many instances there are no symptoms and the condition is discovered in the course of a routine examination. In other instances the patient herself notices a round, movable tumour, which is smooth and firm and accompanied by a sickening pain when handled. There is no connection, as a rule, between the degree of mobility of the kidney and the symptoms it causes.

More commonly the patient complains of a vague, dragging, right-sided abdominal pain, made worse by exertion and walking about and often, but not necessarily, relieved by lying down. This pain is in the loin and iliac fossa and radiates to the thigh, labium or testicle. At times it is accompanied by unexplained attacks of vomiting, and the vomiting is sometimes the only symptom. It is often worse at the periods.

At other times severe exacerbations of these symptoms occur. These attacks are known as *Dietl's crises*, and are due probably to torsion of the pedicle, with kinking and obstruction of the ureter. They consist of very severe attacks of pain in the loin and flank, accompanied by vomiting, rise of temperature and quickening of the pulse. Shivering and abdominal rigidity are often present, while the kidney, if palpable, will be noticed to be tender and enlarged, and the amount of urine may be temporarily diminished. Hæmaturia and strangury are occasionally seen. After some hours, usually less than twelve, the attack suddenly passes off and an increased quantity of urine is passed, possibly with some pus in it. Naturally such an attack may resemble an acute abdominal condition, but the tender mobile and enlarged kidney should render the diagnosis easy.

The patients are frequently of a very neurotic type and are specially liable to become so if they are told that they have a movable kidney. This may be due to the irritation of the sympathetic by the abnormally movable organ or may be an independent constitutional condition.

On examining such a patient the movable kidney usually can be felt with ease, either when the patient is lying flat on her back or in the genupectoral position. On deep breathing it can be felt moving about and will come easily under observation. More than one examination should be made, as it is not always palpable on the first occasion. As already described on p. 819, three degrees of mobility are recognised.

In addition to noting the mobility of the kidney, the greatest care must be taken to observe whether it is normal in size or enlarged, and what its consistency is. It is not likely that this tumour will be mistaken for anything else, such as an ovarian tumour, uterine fibroid, enlarged gall-bladder or Reidel's lobe, if it is remembered that it can be palpated through from the loin between two hands, that it can be made to disappear completely by forcing it up into the renal fossa, and that this is the only type of abdominal tumour which can be made to disappear in this fashion.

A careful examination of the urine must be made, while all other possible causes of abdominal pain must be excluded. The urine will be found to be normal unless secondary changes are commencing in the kidney or possibly immediately after a Dietl's crisis.

Treatment. It is always unwise to tell a patient that she has a movable kidney, for she is liable at once to become neurasthenic, while it should be remembered that in most cases no operation is advisable ; especially if the neurasthenic element is marked operation should be discountenanced, and in these cases much relief can be obtained by setting right any accompanying disturbance of the stomach and bowel, and putting the patient to bed for four or six weeks, while an abundant diet calculated to fatten her, together with massage and electric baths, should be given. A complete Weir-Mitchell treatment is sometimes advisable.

In other cases providing a carefully fitted abdominal support such as the Curtis Belt or Salt's Kidney Belt will free the patient from all symptoms. This is especially so in the cases where the general visceroptosis is marked. All apparatus of this kind must be put on in the morning before the patient gets up, with the pelvis supported on a pillow.

Certain cases remain in which operation is advisable. The indications for this are as follows :—

(*a*) Where repeated Dietl's crises occur. During such a crisis the patient should be put to bed with the foot of the bed raised and hot fomentations to the loin. Gentle manipulation of the loin sometimes will put the kidney back into its place. The resemblance to acute abdominal conditions must be remembered.

(*b*) Any evidence that the kidney is becoming damaged and undergoing secondary changes, such as hydronephrosis, as a result of the mobility. This will be indicated by changes in its size or consistence on examination.

(*c*) Any condition which renders a supporting apparatus unsatisfactory, such as extreme tenderness or mobility.

On the other hand, the presence of marked neurasthenia is a strong contraindication to operation, as also are general visceroptosis and non-relief of the pain when the patient lies down.

The operation to be performed for this condition is known as nephropexy or nephrorrhaphy. It is described on p. 856.

Injuries of the Kidney and Ureter. These are described in full on pp. 519, 520, together with the other abdominal injuries by which they are often accompanied.

HYDRONEPHROSIS

This is a condition in which the pelvis, calyces and, ultimately, the parenchyma of the kidney become distended with urine, the cause always being some form of obstruction to the urinary outflow. This obstruction is never sudden and complete, but always gradual and intermittent. If a complete obstruction of the ureter occurs, as happens if the ureter is tied or suddenly blocked with a stone, absolute cessation of urinary secretion occurs when a sufficient degree of tension within the kidney is set up, and after a time complete atrophy of the kidney will follow unless the obstruction is relieved within a few weeks. If relief occurs within a few weeks the urinary secretion may be re-established. When, however, the urinary outflow is partially obstructed, or completely obstructed intermittently, kidney secretion persists and the increase of pressure will then lead to dilatation and hydronephrosis. The same applies to obstruction in the urethra, where sudden blockage, if complete, will lead to distension and rupture of the bladder but gradual obstruction to hydronephrosis.

If the obstruction to outflow is in the kidney pelvis, the ureter or at the ureteric mouth, the hydronephrosis will be one-sided, while if the blockage is in the bladder or involves the mouths of both ureters, or is in the prostate and urethra, the kidney condition probably will be bilateral.

In some cases the obstruction is completely relieved at times so that the hydronephrosis will disappear at intervals. This is known as an *intermittent hydronephrosis*. In other instances, where an incomplete obstruction is permanently present, the condition does not change and is known as a *permanent hydronephrosis*. This is often due to secondary changes occurring in the urinary passages.

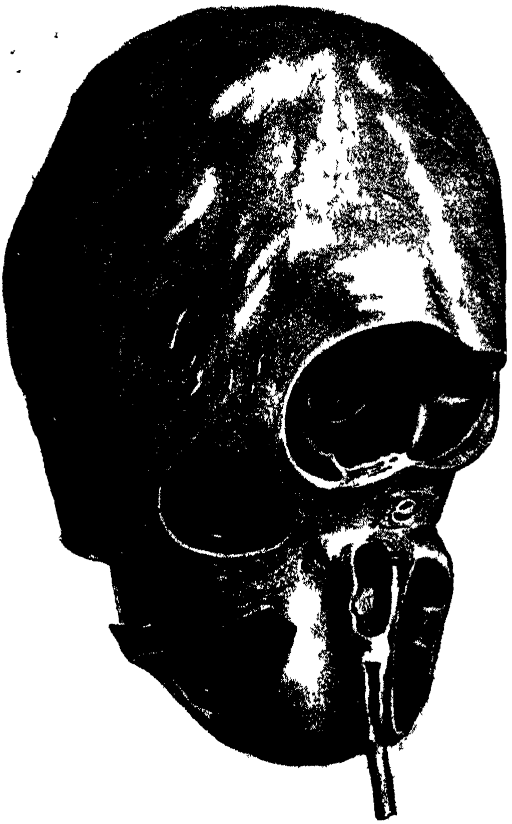


FIG. 279. Large hydronephrosis due to a calculus impacted in the top of the ureter.

If no urine can flow out of the hydronephrosis at all it is a *closed hydronephrosis*, while as long as an outflow is possible it is known as an *open hydronephrosis*.

Causes. The cause of the obstruction may lie anywhere in the urinary tract and may be due to conditions outside these passages, in their wall or inside their lumen.

(*a*) *In the Kidney itself.* The commonest cause here is a movable kidney or one which is misplaced, so that kinking of the ureter occurs. In other instances a calculus in the renal pelvis or a tumour of the pelvis or of the kidney itself will block the outflow (*b*) *In the Ureter.* Here the commonest causes are, again, torsion of the ureter in a movable kidney and impaction of a stone or more rarely a growth in the renal pelvis. An aberrant branch of the renal artery is occasionally seen which crosses behind the top of the ureter and obstructs it, while other causes are tumours of the ureter, tumours of the bladder involving the ureteric mouth, congenital abnormalities such as valves, kinks or strictures, pressure upon the ureter by tumours, especially such growths as carcinoma of the rectum or of the cervix, involvement by scar tissue, which occurs especially after a stone has been impacted in it, and damage to, or ligature of, the tube during gynæcological operations. Blood clots or parasites may block the ureter at times, as also may swelling of its mucous membrane, this latter condition being specially caused by menstruation, sexual or alcoholic excess, and certain drugs such as cantharides.

Inflammatory conditions or abnormal mobility of the kidney sometimes may cause the ureter to adhere to the kidney pelvis at its top end and become obstructed, while the ureteric opening may cease to lie at the lowest part of the renal pelvis. In this way also spurs and kinks at the ureteric opening may arise.

(*c*) *In the Bladder and Lower Urinary Tract.* Any of the causes here will lead probably to bilateral hydronephrosis. They are many and include such conditions as stone in the bladder, tumours of the bladder, diseases of the central nervous system affecting the bladder function, enlargement of the prostate, simple or malignant, urethral stricture, growths of the penis and phimosis or pinhole meatus. Certain functional disorders of micturition also may be causes.

Bilateral hydronephroses are nearly always much smaller than the unilateral ones.

It must be remembered that in a hydronephrosis the urine is uninfected, and should infection supervene the character of the condition will change, and it will become known as a *pyonephrosis.* Unilateral hydronephroses, due to kidney and ureteric conditions, frequently remain uninfected. Those due to disease of the bladder and urethra, on the other hand, soon become infected and are converted into pyonephroses.

Congenital Hydronephrosis. Large congenital hydronephroses are occasionally seen, either uni- or bi-lateral. Such children are often born dead, or the abdominal swelling may be large enough to interfere with the child's delivery. The causes of this condition may be the same as those of an acquired hydronephrosis, *i.e.*, an aberrant renal artery, kinks or folds of the ureter and possibly congenital obstructions of a lower urinary tract. In other cases it is probable that there is a congenitally defective union between the top end of the ureter and that portion of the kidney which is developed from the metanephros, or it may be due to a neuromuscular incoordination.

Pathological Features. The first changes consist in a thinning and loss of elasticity of the pelvic wall. After this dilatation of the ureter above the obstruction and of the pelvis commences. The pyramids become flattened and the calyces expanded. For a time the dilatation remains confined to the pelvis, which may become as large as an orange or larger, the condition then being known as a *pelvic hydronephrosis.* After a while, however, infiltration of the kidney cortex occurs, the kidney substance becoming fibrosed, compressed and absorbed, and the septa between the calyces undergoing atrophy. Finally the kidney substance itself disappears, after becoming stretched and distended, so that the whole condition becomes converted into one multilocular thin-walled sac. It is then known as a *renal hydronephrosis*. In the earlier stages such a hydronephrosis is usually lobulated.

The contents of the cavity consist at first of a pale, watery urine of low specific gravity. After a time the urinary contents disappear and the fluid becomes converted into a thin serous albuminous liquid. If hæmorrhages have occurred into the sac old blood pigment will be present, while at any time infection may arise, when the fluid will become turbid or even thick pus and a pyonephrosis supervenes.

Clinical Features. These naturally depend upon the cause of the condition, for there may be years of history pointing to the cause, such as a renal calculus, a short history indicative of such conditions as tumours, or a story pointing definitely to disease in some other organ, such as the uterus or rectum, to which the hydronephrosis is secondary. In many instances the condition comes on absolutely painlessly and insidiously, a large swelling being the first thing noticed by the patient. Whatever the previous history, the discovery of the enlargement of the kidney is the crucial point in the diagnosis. Changes in the urine will be present frequently, the urine in the early stages often being increased in quantity, pale and of low specific gravity. Pus or albumen may be present, but these changes naturally will depend upon the cause and upon whether the condition is unilateral or bilateral.

The swelling, when it becomes palpable, is a characteristic renal tumour, and fluctuation often can be detected (see p. 809). Movable on respiration at first, it may become very large and in time be fixed by its actual size. Pain, discomfort and aching will be complained of, but it is difficult to say how many of the symptoms are due to the actual hydronephrosis itself and how much is the result of the disease which is the underlying cause.

If the hydronephrosis is intermittent, great variations in the size of the tumour will occur ; it may disappear completely at intervals, suddenly each disappearance being accompanied by an amelioration of symptoms and the passage of large quantities of watery urine. This urine at times will contain blood as the result of venous congestion.

In the early stages, should the obstruction pass off, the kidney may return practically to the normal, and it is in this stage that the diagnosis should be made if possible. The only symptom is then likely to be pain and aching in the loin ; no tumour will be palpable, and the condition therefore may resemble appendicitis and other abdominal lesions. A certain diagnosis can be made only in this early and desirable stage by means of a pyelogram (see below).

As a rule no temperature will be present unless, as may happen at any time, infection supervenes. When this occurs either a pyonephrosis or a perirenal abscess may develop.

In some cases the gradual onset of uræmic symptoms is the first thing noticed, especially in bilateral cases.

In this condition the performance of a routine investigation by means of X-rays and cystoscopy is essential. The X-ray film may show a stone causing the condition, while cystoscopy often will demonstrate the actual cause in the bladder. Moreover, in the early and obscure stages the performance of a *pyelogram*, by injecting sodium iodide into the kidney pelvis by means of a ureteric catheter, will settle the diagnosis. This method is not free from risk and should be performed only by an expert (see p. 810). The size and shape of the renal pelvis will be demonstrated, clubbing, elongation and subsequent enlargement of the calyces being the first detectable change. It is also said that an increase of the acuteness of the angle formed between the ureter and the lowest calyx will be noticed. In early hydronephrosis, or in the case of the large swellings, this method will distinguish them at once from pancreatic cysts, ovarian cysts, ascites, hydatids, etc. A routine examination of the urines also should be performed; that from the diseased kidney will be usually of low specific gravity and deficient in solids.

Treatment. This is directed primarily at removing the cause of the condition, and therefore will depend upon what this cause is. It is, however, usually necessary, in addition, to take steps to preserve or increase the secreting function of the kidney unless this is completely destroyed. The site of the obstruction nearly always can be ascertained by the investigation of the urinary tract already described. A movable kidney should be fixed, an aberrant renal artery resected; folds, valves, kinks, etc., at the top end of the ureter may be cured by plastic operations upon the ureter, by resecting portions of the ureter and joining the ends up or by transplanting the upper end of the ureter into a fresh portion of the renal pelvis. This is especially liable to be necessary in certain forms of congenital hydronephrosis. Stones or tumours should be removed and other conditions dealt with according to circumstances. In a few instances, when no definite cause has been discoverable, stripping the sympathetic plexus off the anterior portion of the renal artery has been of benefit.

If the hydronephrosis is unilateral, and the cause is removable, the operation should be completed by draining the pelvis of the kidney into the loin (nephrostomy). If there is much dilatation and destruction of renal tissue this is essential in order to give the kidney some chance of recovering its powers. Moreover, if a plastic operation has been performed, external drainage of the urine away from the site of the operation for some days will increase greatly the chances of healing and success. If the obstruction is properly removed the renal fistula will close spontaneously.

On the other hand, if the hydronephrosis is bilateral and due to some cause in the bladder, prostate or urethra, removal of the cause and possibly temporary drainage of the bladder is all that can be done, as it is not wise to drain both kidneys in the loin.

Very large swellings may have to be treated by a preliminary aspiration, or, better, by a preliminary incision and drainage (nephrostomy). It will be found occasionally to the surgeon's surprise that, after a simple nephrostomy, the wound heals and the condition is cured, the obstruction having undergone spontaneous relief. Naturally, however, this is rare.

In a great many cases nephrectomy is the only possible treatment. This is especially the case if no kidney substance is left, if the sac is infected, or if the cause of the hydronephrosis is irremovable. Before undertaking this, however, the greatest care must be taken to ascertain whether the opposite kidney is present or not and whether it is functioning sufficiently well to carry on the patient's life single-handed. This must be ascertained by means of the investigations described on p. 809. It will be found in performing a nephrectomy for a big hydronephrosis that the renal pedicle and its vessels are small and atrophied.

Should nephrectomy be contra-indicated for any reason, it may be found necessary in a few cases to provide permanent drainage in the loin. If this is done, in order to keep the patient dry and comfortable, a special apparatus must be provided with a rubber tube passing down the sinus to the kidney and a rubber bag hanging at the patient's back into which the urine is led; in most cases this apparatus works very satisfactorily.

Prognosis. The risk to life in this condition lies either in the condition becoming bilateral, so that renal failure and uræmia may ultimately set in, or in infection supervening. The prognosis in bilateral cases is always bad.

The chances of a damaged kidney resuming its function properly if adequate drainage is provided are fairly good, and if possible steps should be taken to preserve any active renal tissue by this means.

PYOGENIC INFECTIONS

This is an extremely common group of conditions which may be due to many different causes. Different names are given according to the part of the kidney involved and the nature of the infective process: infection of the kidney pelvis being called *pyelitis*, and involvement of the parenchyma being known as *pyelonephritis*. In many cases obstruction to the urinary outflow is present, so that distension of the pelvis and calyces occurs in addition to the infection; this is known as a *pyonephrosis*.

The organisms present are usually B. coli, staphylococci or streptococci, but B. proteus and B. typhosus are sometimes seen.

Two main groups of infection of this kind occur according to whether the organisms reach the kidney:—

(*a*) By means of the bloodstream; here infections tend to localise at first in the renal substance and the papillæ abutting on the renal pelvis.

(*b*) By passing up from an infection of the lower urinary tract. These infections usually commence in the parietal walls of the renal pelvis.

(*c*) A third small group of cases occurs in which the infection reaches the kidney and ureter by extension of a similar infection in a neighbouring organ such as the appendix or colon.

(A) *Hæmatogenous Infections.* This group again subdivides itself into two classes according to whether infection is brought to a kidney previously healthy or to a kidney in which disease is already present, such as a stone, growth, etc. In these latter cases, however, it is often difficult to decide whether the infection, which is superadded to the other disease, has reached it via the bloodstream or lymphatics.

(1) *Primary Bloodstream Infections.* This is a common way in which the kidney becomes infected. It must be remembered that micro-organisms are constantly passing through a kidney which is perfectly healthy when, as is not infrequently the case, they are present in the blood of patients; thus phthisical patients at times will excrete the Bacillus tuberculosis in their urine, though their urinary tract is perfectly healthy. Acute septic infections, therefore, of the kidney may follow upon such conditions as boils, whitlows, tonsillitis, appendicitis, cystitis, or acute fevers. It is clear, therefore, that infection of a kidney is only likely to supervene upon the passage of organisms through it, if it is also damaged by stone, back pressure, abnormal mobility, injury, and such conditions as pregnancy. In pyæmia small emboli will reach the kidney and if infective give rise to septic lesions.

The pathological changes that occur in the kidney will depend largely upon the causative organisms; thus staphylococci or streptococci give rise to an inflammation of the renal substance in which many small abscesses will occur, some of which may fuse together to form larger abscess cavities, while the abscesses are especially liable to be found in the cortex of the kidney. On the other hand, the coli group of organisms does not, as a rule, produce suppuration for some time at least. Bacillus proteus is a not infrequent causative organism

Though these bloodstream infections essentially start in the renal substance, they frequently and rapidly involve the pelvis and give rise to a pyelitis, from whence, of course, infection may spread down the ureter to the bladder (*descending pyelonephritis*).

(2) *Infections Secondary to Disease of the Kidney.* If the kidney is already diseased, being involved by such conditions as a growth, a stone, tuberculosis, etc., septic infection is certain to set in sooner or later, the organisms reaching the organ probably by the blood and possibly in one of the ways described below. The processes and pathological changes which then occur are exactly similar to those described above, either pyelitis, pyelonephritis or pyonephrosis supervening. They tend, however, to be even more severe.

(B) *Ascending Infections.* Another equally common type of infection of the kidney is that which occurs as a result of infections of the lower urinary tract (bladder, prostate and urethra). This condition is not unnaturally often bilateral, and was at one time known as "*surgical kidney.*" It is especially common when, as well as infection, there is also some degree of urinary obstruction, as occurs in stricture or enlarged prostate, while it is sometimes seen to follow upon cystoscopy, ureteric catheterisation or operations upon the bladder where infection has occurred. Gonorrhœa does not often give rise to it.

It was at one time thought that this type of infection ascended from the bladder to the kidney up the inside of the ureter, in the lumen of the tube, but this is highly unlikely, and experimental work has shown that it rarely occurs; while the fact that the ureters pass through the bladder musculature for some distance in an oblique direction also renders this unlikely. It is probable that such ascending infections really ascend in the lymphatics which run up in the wall of, and in the tissues surrounding, the ureter. In some cases they may arise also by means of the bloodstream.

Absorption of toxins or organisms is probably much less marked from the bladder than it is from the posterior urethra: hence a urethritis is more likely to cause a renal infection than is a cystitis.

Most commonly this condition gives rise to a diffuse infection of the kidney known as an *ascending septic pyelonephritis.* Pyelitis will occur often, frequently only as a first stage, while, as an obstructive element is marked, a pyonephrosis is by no means uncommon.

The passage of urethral instruments, such as sounds or catheters, is particularly liable to set up mild degrees of infection of this kind (*catheter fever, urethral rigor*).

(C) Infection via the lymphatics from the adjacent colon is not uncommon, especially when chronic constipation is present, and may cause many cases of B. coli pyelitis. In the rare cases where the infection involves the kidney by direct extension from disease in some neighbouring organ it usually will be found that some condition such as acute appendicitis, a retrocolic appendix or an appendix abscess which has burst into the ureter or bladder, is present.

(1) **Pyelitis.** This is a condition where one of the above infections involves only the pelvis of the kidney, the ureter and parts of the calyces. Acute inflammation of the lining membrane is present, with redness, congestion and a mucopurulent discharge. The swelling of the mucous membrane may be sufficient to give rise to some obstruction at the top of the ureter, while an

accompanying pyelonephritis may or may not be present. The condition very rarely occurs unless some predisposing cause is present. This may be pregnancy (when it is almost always on the right side), a calculus, a growth of the kidney, a movable kidney, pyæmia, irritation due to bilharzia or such drugs as cantharides, cubebs or copaiba, while tuberculous or other infections of the kidney or bladder may be present (see p. 842). In many cases the causative organism is the B. coli.

Clinically the condition is most common in women and on the right side, where it gives rise to a sudden onset of pain and tenderness over the kidney, marked frequency, a considerable rise of temperature with attacks of shivering, and possibly aching in the bladder and scalding micturition. The symptoms may therefore be divided into the two groups of kidney or primary symptoms and bladder or secondary ones. The urine contains pus and is nearly always acid, but the pus is, however, not constantly present. If cystitis is present also, the urine probably will become alkaline in the bladder before it is passed. The tongue is dry, the pulse rapid and the patient often very ill. There are marked rigidity and tenderness high up in the right flank, while the kidney is not usually palpable.

On cystoscopy the only abnormal change to be noticed apart from an accompanying cystitis or a visible causative lesion in the bladder will be a puffiness and redness of the ureteric mouth, while the urine coming from that ureter will be seen to be opaque with pus. If the disease is of the simple catarrhal variety no pus may be present at first. A bacteriological examination always should be made.

Pyelitis of Pregnancy. This is a common condition and occurs in the last few months of pregnancy. The pathological changes are exactly the same as those referred to above, while the infection is probably precipitated by the renal congestion and back pressure produced by the uterus pressing upon the ureter at the pelvic brim. The condition is always on the right side, and this may be due to the long axis of the fœtal head usually lying in the right oblique diameter. The condition often persists till the uterus is emptied either naturally or artificially. It then soon clears up. For the diagnosis from appendicitis see p. 723.

Treatment. At first this consists in removal of the cause, and in many cases the treatment of such conditions as stones, strictures, enlarged prostates, etc., will effect a cure ; especially is this so if the condition is due to some removable cause in the lower urinary tract, while it will be seen that this necessitates a more or less complete urinary investigation. In addition to this, rest in bed with a light diet, plenty of fluids and urinary antiseptics in the form of urotropin, buchu, potassium citrate, benzoic acid, sulphanilamides, mandelic acid, etc., will be useful, while a *ketogenic diet* rich in fats and other substances containing vitamins A and D is valuable in clearing up both acute and chronic cases (see p. 867). The symptoms usually pass off in four or five days, but there is often a considerable tendency for the disease to become chronic, and when this is so much benefit will be obtained by passing a ureteric catheter into the renal pelvis and instilling small quantities of collargol or very weak silver nitrate. In very intractable cases a temporary drainage of the kidney in the loin will be necessary. Vaccines are often helpful. A few cases of pyelitis of pregnancy have occurred in which in spite of treatment the condition has progressed so far and so rapidly that nephrectomy has had to be performed. In this last type lavage by an indwelling ureteric catheter may give good results, but should be attempted only by an expert and in an institution.

(2) **Pyelonephritis.** Here both the pelvis and the substance of the kidney are infected and inflamed, while suppuration occurs sooner or later. At first the kidney is red or purple and swollen, while after a time minute multiple abscesses become scattered throughout the more superficial parts of the organ, and especially in the cortex ; the pelvis is red and inflamed and the medulla of the organ becomes streaky in appearance. In addition to this a considerable degree of interstitial nephritis will be present in chronic cases. In the course of time larger abscesses will be formed, while the condition will tend slowly to pass into a pyonephrosis. The condition is due almost invariably either to diseases of the kidney, such as calculus or growth, when it is unilateral, or to a septic cystitis. In this case it may commence very suddenly following upon catheterisation or some operation upon the bladder, and will then be bilateral very often.

Clinical Features. This is a much more serious condition than pyelitis. In most instances the patient has already had symptoms pointing to previous disease of the kidney or bladder, especially the latter, and in many instances the symptoms come on suddenly and acutely, often following an operation. There are one or more severe rigors, with a temperature of 104° or more, and with aching pain in the loin, headache, vomiting, thirst and constipation. There are often pain in the bladder and penis, and marked frequency, while the tongue is brown, dry and coated. The patient will be drowsy or may pass gradually into coma, while the kidney, though tender, is not likely to be enlarged sufficiently to be palpable. The urine becomes diminished and scanty, and will contain pus and albumen, often blood and casts. Sometimes it is completely suppressed. Many cases gradually sink and die from uræmia within two or three weeks, death being preceded by a subnormal temperature and coma. This is especially likely if chronic renal or bladder infection has been present for some time, as the condition is then probably bilateral. In other and less chronic cases improvement often occurs, but recurrence is frequent and a large abscess often will form in the kidney after some time.

Cystoscopy should not be performed in acute cases.

More chronic cases are sometimes seen where there is only slight temperature and practically no pain, though here it is probable that an enlarged and tender kidney may be felt. The urine again contains casts, albumen and pus, and is usually alkaline. Gradually wasting, loss of appetite and general failure of function set in, while the patient becomes a peculiar muddy or earthy colour. Œdema and signs of chronic interstitial nephritis also will occur, and uræmia gradually sets in, followed by death. This type of case is seen especially after injuries of the spine, followed by interference with the bladder function. Here, however, if the cause can be removed, considerable improvement will follow, though the kidney will be left permanently damaged.

Treatment. This will depend upon how acute the condition is. If it is chronic the cause must be discovered and treated, though operations must not be rushed into without due thought, as acute exacerbations are liable to be set up. If possible the cause must be removed, though in many instances it will be wise before doing this to wash out the bladder or drain it temporarily, while efforts may be made to reduce the infection by means of rest in bed, plenty of fluids and urinary antiseptics. If the B. coli is present a vaccine and ketogenic diet (see p. 867) often will be of considerable value, while the administration of mandelic acid and ammonium sulphate, or, better, one of the more palatable medicines combining these, often is productive of success. Mandelix or Neoket are excellent in this respect, while in many cases sulphanilamides exert a most beneficial effect.

In the more acute forms little can be done to remove the cause and the treatment becomes that of uræmia or of threatened uræmia, so that the patient is given plenty of fluids, kept warm in bed, and encouraged to excrete in every possible way. Thus hot-air baths, hot-air packs, hot-water baths and pilocarpin may make him sweat. Watery purges in the form of jalap or magnesium sulphate should be given. Hot cupping to the loin is often useful. In many instances urinary secretion cannot be restarted even by this means, and if all else fails, whichever kidney is thought to be the better should be exposed and its pelvis drained. This often will start secretion again. Drainage of the kidney will be necessary also if suppuration or abscess formation occurs.

The best that can be hoped for usually is that the patient will recover with damaged kidneys and probably chronic cystitis and nephritis.

(3) **Pyonephrosis.** This is the condition which occurs when, in addition to a septic pyelitis or pyelonephritis being present, some obstruction to the urinary outflow also exists. Its causes, therefore, will be, in the main, very much the same as those of hydronephrosis, and it usually will be unilateral or bilateral, according to whether the obstruction is in the upper or lower urinary passages. The commonest causes are undoubtedly calculi in the ureter and kidney (*calculous pyonephrosis*), or tuberculosis, when the obstruction is due to swelling of the mucous membrane.

The infection in all these cases reaches the kidney by any of the methods described already on p. 826. It must be remembered also that in many instances a phosphatic calculus is formed within the pyonephrosis as a secondary result of the decomposition and stagnation of the urine.

In this condition the kidney will pass first through the changes already described under pyelitis and pyelonephritis, but with the onset of retention and distension the calyces become distended and the pyramids disappear, a number of abscess cavities being formed, all of which communicate with the pelvis. In pyonephrosis distension of the pelvis does not occur to the same degree as in hydronephrosis, probably because of the chronic inflammatory thickening of its walls, and the stress of the infection and dilatation appears to fall more upon the kidney substance. This does not, however, apply to those cases which are really infected hydronephroses. Thickening and ulceration of the pelvic wall occurs, while its cavity becomes lined with granulation tissue, and any kidney substance which remains will be found to be tough, white and fibrotic. Changes also occur in the neighbouring structures; the walls of the ureter usually become thick, white and adherent to the peritoneum, while, though its lumen is usually dilated, it is often blocked up with inspissated pus and débris.

Marked chronic inflammation of the perinephric tissues will occur with fibrosis, with the result that the pyonephrosis becomes densely adherent to all the surrounding structures, such as the perinephric tissues, the muscles, the peritoneum, the duodenum, aorta or vena cava, while the blood vessels in the renal pedicle are thickened, shortened and contracted. Infection and suppuration will occur sometimes round the kidney in the perirenal tissues, and sometimes a large perirenal abscess will form, which may at times communicate with the inside of the pyonephrosis. A great deal of perirenal fibrolipomatous inflammatory tissue is often formed.

The contents of a pyonephrosis consist of pus, débris, and decomposing urine, while soft, pultaceous masses of phosphates are often present. At times the actual cavity within it is remarkably small, while the wall of tissue surrounding it may be 2 or 3 inches thick. The pyonephrosis may be a little bigger than a normal kidney or may reach the size of a Rugby football.

It often happens that the true capsule of the kidney is less affected by inflammation than any of the neighbouring structures.

Clinical Features. There nearly always will be a long history pointing to the cause of the condition, such as a stone, growth, enlarged prostate, stricture, etc., while previously to the onset of the pyonephrosis the signs and symptoms of pyelitis or probably of pyelonephritis will have been present. *The only additional sign which indicates the onset of a pyonephrosis is the presence of an enlarged, hard, tender, palpable kidney, which is usually fixed and immovable. Pain and aching, especially at night, are present, while intermittent attacks of fever are always seen, the fever sometimes being high and accompanied by rigors.* Pus is nearly always present in the urine. It may be intermittent, however, in those cases where the outlet from the kidney becomes temporarily blocked (*closed pyonephrosis*). Should this temporary blockage occur there will be increase of pain and fever, while the pyonephrosis may be felt to vary in size from day to day. If permanently closed there may be no pyuria. The urine is often scanty and high-coloured, the tongue dry and furred, and the patient slowly becomes weak and thin and develops the muddy colour associated with a urinary septicæmia. If the condition is bilateral the patient will sink slowly and die from uræmia.

A complete urinary investigation is required. An X-ray film may show a causative calculus or the presence of a secondary calculus or diffuse calcification in the kidney. Cystoscopy is invaluable in demonstrating the pus coming down from the ureter and ascertaining the condition of the other kidney.

Some cases will be seen where the pyonephrosis has evidently been present for years and yet has given rise to practically no symptoms.

Treatment. It is of great importance to remove the primary cause if possible, and in the case of a bilateral pyonephrosis this is probably the only treatment which can be undertaken. There is very little chance that a pyonephrotic kidney will ever recover to any marked degree, and if the condition is unilateral something will have to be done to the kidney itself as well as removing the primary cause. The choice will lie between nephrectomy and nephrostomy.

Nephrostomy consists of simple drainage of the kidney through the loin; it should be employed in the milder cases, where it is hoped that by this means some amount of renal function may be preserved or regained; for this to be advisable it is essential that something should be done to re-establish the flow of urine down the ureter. Nephrostomy is also valuable in the very big and advanced cases where, on account of its size and adherence, removal of the pyonephrosis is mechanically impossible. In this case a preliminary drainage of the kidney for two or three weeks often will diminish the size and adherence of the kidney sufficiently for a subsequent nephrectomy to be possible. A sinus is almost certain to persist until the kidney is removed.

Nephrectomy is the operation of choice in severe or advanced cases where the kidney is more or less completely destroyed or where the primary cause cannot be removed. If a perirenal abscess is present in addition to the pyonephrosis it will also be advisable. It may be, however, a very difficult operation. It demands, of course, that the other kidney shall be functioning satisfactorily, and is best performed by the lumbar route.

Perirenal Abscess. This is a not uncommon condition, which is the result of suppuration in the loose and easily infected perirenal fat. Two chief varieties are seen which are known as the primary and secondary forms.

(A) *Primary Perirenal Abscess.* This is the type in which there is no disease of the kidney, this organ being healthy. Infection reaches the perirenal fat by means of the bloodstream or lymphatics as an embolic process, and it will be found that there is always a small focus elsewhere in the body from which the organisms have come. This may be a boil, pustule, impetigo, attack of tonsillitis or a whitlow, and the perirenal abscess often does not appear for some weeks after this primary lesion has healed. These cases are usually unilateral.

Another form of primary perirenal abscess is occasionally seen where the infection is due to direct extension from inflammatory disease in a neighbouring organ, such as the appendix, gall-bladder or spine. An empyema will give rise to this condition occasionally. In general septicæmia and pyæmia a perirenal abscess is a not uncommon complication.

(B) *Secondary Perirenal Abscess.* This is the result of direct extension from an infective disease in the kidney. It is thus a not uncommon complication of pyelonephritis or pyonephrosis, the infection having burst through the kidney capsule into the surrounding tissues. It often follows an injury to the kidney, especially if urine leaks out of it.

A chronic form of perirenal infection (*perinephritis*) is sometimes seen around kidneys involved by stone, tubercle, pyonephrosis, etc. This leads to a marked formation of adhesions and an extensive deposit of fibrolipomatous tissue, which fixes the kidney and renders it very difficult to remove.

Clinical Features. This condition varies greatly in acuteness, the time taken for a palpable swelling to form varying from a few days to a few weeks. Pain and tenderness in the kidney region, accompanied by fever, malaise and vomiting and rigidity of the perirenal muscles, will be seen, tenderness being specially marked below the twelfth rib. The hip is often flexed up, and in the course of a varying time a palpable, tender, hard swelling will be detected lying in the loin and quite fixed; fluctuation is difficult to observe, and the tumour has not got the shape of the kidney. Occasionally hæmaturia is present, but in the primary form the urine probably will be normal, and in the secondary form it will contain pus and albumen. In some instances the onset is very acute, accompanied by rigors and very high temperature, while in the milder cases where the patient is able to walk about, the body is held stiff and inclined towards the painful side. If neglected the abscess will come gradually to the surface and a visible swelling with redness and œdema will appear in the loin, either at the side of the erector spinæ or further forwards over the abdominal muscles. Such an abscess has burst occasionally into the pleura, the bowel, the peritoneum or the renal pelvis.

These swellings tend to bulge back into the loin more than do renal swellings, while they are very fixed; muscular rigidity is very marked.

Superior, posterior and inferior types of perirenal abscess have been described, this depending on the position of the kidney with reference to the abscess. No useful purpose, however, is served by this classification.

Treatment. As soon as the condition is recognised the abscess should be opened by an incision in the loin outside the erector spinæ. In the primary cases this is all that is necessary, and after a few days' drainage the wound will heal. If, however, it is found that the kidney is grossly diseased, this should be drained also; later, a nephrectomy should be performed, as otherwise a sinus probably will form and the wound refuse to heal, while the condition will tend to become chronic.

Cold abscesses from the spine are occasionally seen in this situation; they should be treated as described on p. 130.

Renal Abscess. A renal abscess is frequently seen in connection with any of the forms of renal infection described above. Indeed, it may be regarded as a more or less essential stage in their progress. Pyæmic abscesses in the substance of the kidney are, however, sometimes seen as a result of infection in other parts of the body of varying grades of severity in exactly the same way as occurs in primary perirenal abscess. They are occasionally also the result of infarcts of the kidney which have become infected.

Pain, tenderness and rise of temperature will occur, while the kidney can be felt to be enlarged and tender. In chronic cases the infection is more often tuberculous. Pus may or may not be present in the urine.

If not properly treated the condition probably will spread and give rise to a perirenal abscess.

The treatment consists in drainage or removal of the kidney according to the circumstances.

Renal and Perirenal Carbuncle are occasionally met with in debilitated subjects, who become acutely ill with the signs of a renal or perirenal abscess, together with agonising tenderness and œdema in the loin. Treatment consists in excision and drainage, or nephrectomy in a few cases, but the prognosis is very grave.

Renal Sinus. A renal sinus discharging urine on to the skin is occasionally seen, while fistulæ between the kidney and the bowel or lung have been described; there is always a communication with the pelvis of the kidney. Such a sinus nearly always will heal spontaneously unless some obstruction to the ureter such as a stone or growth is present, or unless the kidney is grossly diseased. It usually discharges both urine and pus. Any possible cause such as a stone should be removed; if this does not cure the sinus, nephrectomy will have to be considered. This may be very difficult because of scar tissue, and an alternative operation which will diminish the discharge is to tie the renal artery by laparotomy.

Infarct of the Kidney. An infarct of the kidney is not uncommon; it is seen in septicæmia and pyæmia, while it sometimes occurs after operations as a result of venous thrombosis and embolism.

Sudden pain and aching occur in the renal region, accompanied possibly by a little rise of temperature and usually an attack of hæmaturia which generally does not last very long. In the kidney the infarct appears as a wedge-shaped area, chocolate-coloured at first and later on becoming yellowish or white. If the embolus is sterile the condition will settle down completely in two or three days, while if infected a renal abscess probably will form.

Bright's Disease. *Acute and chronic nephritis* are usually regarded as purely medical diseases, and they really only have two important surgical aspects. In the first place any surgical disease of the bladder, kidneys or urinary tract, if it persists for some time, is almost certain sooner or later to give rise to chronic interstitial nephritis, which may or may not be accompanied by any of the forms of septic infection of the kidney described above. Obstruction to the urinary outflow is especially liable to give rise to this condition.

Secondly, the question of operations to be performed upon patients with chronic renal disease not infrequently arises, for this constitutes an added risk in case of any operation, and especially is this so with regard to operations on the urinary tract. This is discussed on p. 812.

The surgeon is occasionally asked to undertake the treatment of severe or advanced cases of renal disease when uræmia is present or imminent. Most commonly this arises in connection with advanced chronic renal disease, but in eclampsia or acute scarlatinal nephritis the same position may arise. Two surgical procedures have been practised, and there is no doubt that both of them are occasionally productive of benefit.

Edebohl's operation consists in a complete decapsulation of one or both kidneys, performed in the hope that this will diminish congestion and increase the circulation in the kidney by the formation of new blood vessels running into its substance. It is thus not likely to produce any marked effect for two or three weeks. The kidney or kidneys are exposed in the loin, brought up to the surface, the capsule incised and completely stripped off them, and the organs returned to their bed.

The other operation for these conditions consists in a *nephrostomy* or temporary drainage of the kidney and its pelvis. This is more suitable for cases of acute nephritis or other instances where suppression of urine has set in, as any effect it may have is much more rapid, and by providing drainage it may just suffice to stimulate the kidneys to secrete urine for a few days until their normal function is resumed.

URINARY CALCULUS

The presence of calculi practically anywhere in the urinary tract is by no means uncommon. Though in some instances calculi may be formed in the bladder, there is no doubt that the great majority of urinary calculi are formed primarily in the kidneys, whence they may migrate to other parts of the tract. Thus wherever in the urinary tract a stone occurs, in the main the same variety of chemical constituents will be present, although local factors such as infection, etc., may introduce modifications.

Renal Calculus. Urinary stones consist of solid materials deposited from the urine and are usually impregnated with, and held together by, organic constituents of an albuminous nature, such as fibrin or shed renal epithelium. In some instances the urinary salts are deposited upon a central core or basis composed of such substances or even of clusters of bacteria. In the kidney branched and irregular stones are common.

Renal stones are nearly always composed of uric acid, calcium oxalate or urates of ammonia, sodium and potassium, and in nearly every case the condition appears in patients who have already been suffering from lithiasis and the passage of corresponding crystals, sand or gravel in the urine for some months or years.

(1) *Calcium oxalate* stones are black, dark brown or purple in colour, hard, knobbly and opaque to X-rays, and usually occur in adult patients. The crystals are either regular octahedra or else dumb-bell shaped and occur in acid urine. On section the stones may have a concentric laminated appearance. They are sometimes known as mulberry calculi; the dark purple colour is probably due to an admixture of blood pigments.

(2) *Uric acid* stones are usually reddish or yellowish in colour, soft, smooth and semitransparent to X-rays. They are most commonly multiple and are seen in adolescents and usually occur in an acid urine. The crystals are usually white and needle-shaped, but they may be flat, rhomboidal or lozenge-shaped. Pure uric acid throws no shadow in an X-ray film, but luckily most stones are mixed in structure.

(3) *Urate stones* are commonest in children; they are soft, reddish or brick-coloured, smooth, only slightly opaque to X-rays, and occur in an acid urine. The crystals are often amorphous or round spiculated globes. Sodium and ammonium urates are those most commonly present. They are usually multiple.

(4) *Phosphatic Stones.* These are more common in the bladder than the kidney. They consist of triple phosphates or of the phosphates of calcium and magnesium, and only occur in alkaline urine. Thus, in many instances, the urine becomes alkaline as the result of infection, and this causes phosphates to be deposited, this constituting what is known as a secondary stone. Phosphates, moreover, often are deposited in the substance of or upon the surface of stones which primarily consisted of one of the other types described above. Phosphatic stones are white or grey, soft and opaque to X-rays; they grow rapidly and have a rough surface; they are often associated with a foul ammoniacal urine full of staphylococci, when they may be accompanied by calcium carbonate.

(5) *Cystine stones* are very rare. They are greenish in colour and soft and greasy to the feel, appearing semitranslucent. They are preceded by cystinuria and cast a very dense shadow on an X-ray film due to the presence of sulphur. The urine may be acid or alkaline.

(6) Other very rare calculi are the *xanthin* stone, which is reddish brown, and the *indigo*, or blue stone. *Bloodstones,* soft brown calculi, consisting of altered blood pigment and phosphates, are occasionally seen.

Renal stones are composed nearly always of the same chemical substance throughout, and on section they therefore usually do not appear laminated; in this way they differ from bladder stones. Occasionally, however, as a result of infection, an outer coating of phosphates is deposited upon them, and this, of course, renders them opaque to X-rays. In most cases crystals pass directly through the renal tubules into the pelvis and ureter. If, however, the tubes are narrow or they are obstructed in any way, the crystals become held up, and then begin to increase in size by the deposit of further material, so that in this way stones are formed.

Renal stones are often multiple, when they are faceted, and not infrequently bilateral. They are frequently small, when they may lie in the pelvis or one of the calyces, or they may be large and branched so as to form roughly a complete cast of the calyces and pelvis. Small stones occasionally appear to lie right in the substance of the kidney, but they are always in communication with one of the calyces; sometimes there is a small pyramidal elongation extending down the ureter for a short distance. Little is known for certain about the actual causes of renal calculi. They are, of course, far more common in hot climates when the urine is concentrated. It is possible that deficiency of vitamin A may play a part in their formation, while metabolism and colloid-chrystaloid combinations do so also.

Changes in the Kidney. Once a stone is formed in the kidney or its pelvis the onset of one or other of the forms of renal infection, already described on p. 826, is almost certain to occur sooner or later, pyonephrosis being perhaps particularly common as the end result. Apart from infection, the mechanical irritation of the calculus, possibly combined with a certain amount of urinary obstruction, gives rise to interstitial nephritis, with fibrosis, so that the kidney becomes tough, hard and adherent. Its capsule is unduly fixed, and the organ unduly adherent to the surrounding structures. In other instances, when the stone lies further away from the pelvis and more in the renal parenchyma, it may become more or less encapsuled by fibrous tissue and give rise to very little trouble. Hydronephrosis often will occur, and in other instances, as the result of either septic pyelonephritis, pyonephrosis, or perirenal suppuration, pus formation outside the kidney will commence, the abscess bursts externally, and the stone is discharged. This, of course, probably will lead to a urinary fistula.

It sometimes happens, as a result of chronic irritation and inflammation, that a large amount of fibro-fatty tissue is deposited in and around the kidney, which ultimately will become converted into a mass of this tissue, with a suppurating cavity in its centre containing the calculus.

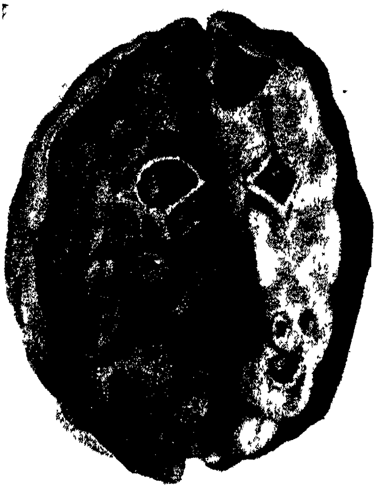


FIG. 280. Calculous pyonephrosis.

It must be remembered that, even though no obstruction of the ureter is produced, one or more calyces may be blocked by the stone, and thus local dilatations of the kidney will occur. Not infrequently stones pass down into the ureter and become impacted there (see p. 839).

The opposite kidney may be healthy or may undergo exactly similar changes. In some instances a compensatory hypertrophy occurs. Occasionally the irritation of a calculus will lead to carcinoma or other malignant growth in the kidney.

Clinical Features. There is no doubt that stone is particularly common in certain countries and certain districts, though this applies more to stone in the bladder than in the kidney. Thus in England it occurs frequently in the eastern counties and Derbyshire, as is also the case in tropical countries and the East, especially such countries as Egypt, India, and China. It is equally common in the two sexes, and though it may occur at any age, it is most usually seen between twenty-five and sixty ; there is often a tendency for it to run in families, but this may be the influence of the locality of residence.

The symptoms of which a patient complains will vary greatly and often be vague. They naturally will depend upon how marked the infective element is and whereabouts in the kidney the calculus lies. In some instances a stone will be present in the kidney for a long time without giving rise to any symptoms at all (*latent stone*). The cardinal symptoms are pain and hæmaturia.

Most commonly the patient will complain of pain or aching in the renal region at the back below the twelfth rib, and also in front in the loin. This is often persistent, and is frequently referred down to the groin, testicle, labium and thigh, while it is often made worse by jolting or shaking. The patient indicates the site of the pain by placing the tip of the thumb just below the last rib. In most instances slight attacks of hæmaturia occur, especially after jolting or shaking, and sometimes this is the only or the first symptom noticed. It is often found that big stones cause less severe symptoms than small ones. In addition to this dull, aching pain, it frequently happens that paroxysmal attacks of far greater severity occur, and these are known as renal colic.

Renal Colic. In more pronounced cases this colic occurs as a result of spasmodic contractions of the pelvis and the top of the ureter in an effort to get rid of the stone. In many cases, however, so-called renal colic is really due to ureteric colic, the stone having passed into this tube. Renal colic often sets in after jolting or shaking, and gives rise to the most intense sickening pain, starting at the back of the loin and radiating down into the iliac fossa, the testis or labium, and thigh, *i.e.*, the distribution of the genitocrural nerve. It may radiate to the perineum and bladder. Collapse is marked ; nausea, vomiting, retching or belching of wind, and shivering are present, the onset being sudden, while after a few hours it ceases suddenly also. The pulse is poor and slow, the patient covered with a cold perspiration, while he lies shouting and writhing in agony. The pain often comes and goes every few minutes, aching being present in between. The abdominal muscles will be found rigid, and the kidney region tender, while often there is a frequent and intense desire to pass water, though little can be produced (*strangury*). The testis on the affected side is usually tender and drawn up tightly by the cremaster. Either during or after the attack hæmaturia almost always occurs. Attacks of renal colic may be followed later by symptoms of stone in the bladder (see p. 870) or the passage of a stone down the urethra.

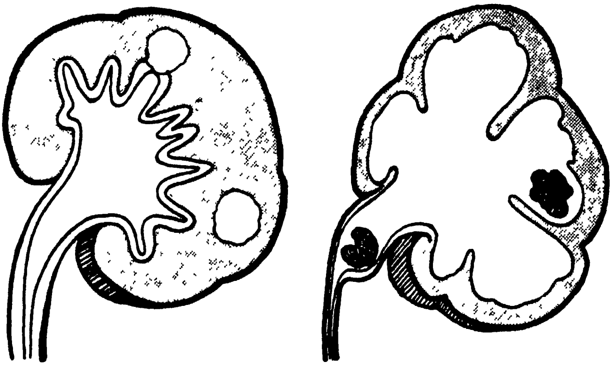


FIG. 281. Diagram of the difference between tuberculous and calculous pyonephrosis. A, (tuberculous) Lining of pelvis and ureter thickened ; caseous foci in cortex. B, (calculous) Ureter small, pelvis dilated.

It must be remembered that other conditions besides a calculus will cause renal colic—in fact, any obstruction of the ureter or any foreign body in the tube. Thus bloodclot, thick pus or caseous material, crystals, pieces of growth, or kinking of the ureter may all give rise to it.

Very rarely the pain of a renal calculus is felt on the opposite side.

It must be remembered also that many cases of stone, especially where it is large, never get renal colic.

On examination of a kidney with a stone in it, slight tenderness may be present, especially in the costovertebral angle, but it is not likely that the kidney will be enlarged or palpable unless infective changes or hydronephrosis are becoming advanced. In some instances frequency is a marked symptom ; this is not necessarily due to an accompanying cystitis, but may be reflex.

Examination of the urine is important ; small amounts of blood are often found, especially in the evening, while blood visible to the naked eye is frequently present, in which case the urine is usually smoky. Slight amounts of albumen and polyuria, with a urine of low specific gravity, are often seen.

If infection is superadded, as is not infrequently the case, any of the signs and symptoms associated with pyelitis, pyelonephritis or pyonephrosis will be present, while the urine will be full of pus and organisms.

It must be remembered that there is always a possibility of a stone becoming impacted in the ureter (see p. 839). A useful test, especially if no X-ray film is available, is to make the patient bend laterally rapidly five or six times towards the affected side, when pain is usually experienced and renal colic may be set up if a stone is present.

To complete and render the diagnosis certain in these cases other investigations must be undertaken. In the first place, careful X-ray films must be taken, and these must include both kidneys, the ureters, and the bladder; there are few renal calculi sufficiently free from phosphates not to cast a shadow. The methods employed for photographing the kidney will be found in Chapter XXIII., Vol. I. A good film should show the outline of the kidney itself and of the psoas muscle. It should be remembered that if the stone is in the kidney pelvis its shadow will be opposite the bodies of the first or second lumbar vertebræ. No visible shadow is almost certain evidence that no calculus is present. In the case of all these adequate preliminary purgation is essential.

If a shadow is discovered it must be remembered that it may be due to calcareous glands, calcification in blood vessels and costal cartilages, calcareous deposits in an infected kidney, or even to gall-stones, though the position of the shadow is often characteristic. Confirmation, however, may be obtained by taking stereoscopic pictures, by performing a pyelogram, or by taking other photographs with an opaque bougie passed up the ureter into the kidney pelvis; for by this means the position of the suspected shadow may be compared with those of the bougie or the pyelogram, which are known to be in the kidney.

A pyelogram often will show the exact size and situation of the calculus, as well as whether it lies in the renal cortex.

Cystoscopy, moreover, always will be necessary to ascertain the condition and function of the opposite kidney, as the possibility of removing the one which contains the stone may arise, while tests of the renal function always should be performed before undertaking an operation. On examination with the cystoscope the ureteric mouth on the side on which the stone is present is often red, congested or œdematous. Blood may be seen coming from this side if the kidney is massaged.

It must be remembered that after all these clinical tests have shown that a calculus is present in the kidney, it is not always easy to find it at operation, and the surgeon must be alive to the possibility of more than one stone being present, or of fragments becoming broken off and left behind.

Treatment. In early cases, where only lithiasis, gravel or oxaluria (see p. 839) are present, or if an X-ray film shows only a very small and early stone, the treatment should be medical and dietetic, consisting largely of diluting the urine as much as possible. Milk, cream, butter and phosphates should be taken in excess and large amounts of fluid should be drunk, and alkaline waters, such as Vichy or Contrexéville, are specially valuable. Potassium citrate and magnesium or sodium sulphate are also prescribed, while the patient's diet must be rendered free of purine bodies, and he should be instructed not to lead too sedentary a life. The object of this treatment is to reduce the stone in size so that it will become loose and pass down the ureter. Occasionally it will become encapsulated and give rise to no further trouble. Urotropin and urinary antiseptics may be used in the hope of delaying or diminishing infection.

When an attack of renal colic is present, the patient must go to bed and be given a reasonably large dose of morphia or atropin, or both. Hot baths and hot local applications, such as antiphlogistine, will help to relieve the pain, but severe cases even may require chloroform.

In most cases, however, operation is by far the wisest treatment. This is especially indicated if the stone is other than very small, is getting bigger, is giving rise to severe symptoms, such as pain, colic or hæmaturia, or if there is evidence of infection or that the kidney is becoming damaged. If the stone is in the pelvis it may be removed by *pyelolithotomy* without damaging the kidney, while if it lies in the kidney substance *nephrolithotomy* will be necessary (see p. 856). In many cases, however, where much infection or pyonephrosis is present, a *nephrectomy* will be the only course, provided the other kidney is efficient.

Stones are not infrequently encountered in both kidneys, but this is no objection to removing them, the side on which the kidney appears to be the least affected being done first. If bilateral stones are present a nephrectomy should not be performed, whatever the condition of the kidney.

Recurrence after stones have been removed from a kidney is not likely, provided reasonable care in after-treatment is taken, unless the kidney is badly infected and damaged. In this case the results probably would have been better had it been removed at the time of the first operation.

Oxaluria. This is a not uncommon condition in which the passage of crystals of calcium oxalate will give rise to symptoms closely resembling those of stone, namely, renal pain, renal colic, and hæmaturia. It is especially common in nervous, dyspeptic, hypochondriacal young people, who are usually pallid and constipated. It sometimes comes on in particularly severe attacks after eating certain fruits and vegetables, such as asparagus, rhubarb, strawberries, apples and spinach. An X-ray film and cystoscopy are both negative, and the urine contains nothing abnormal except a little blood and the characteristic dumb-bell shaped crystals. Sometimes the only symptoms are painful micturition and a muco-purulent urethral discharge which makes the patient suspect gonorrhœa, and may cause the doctor to diagnose this erroneously unless a smear is examined, when the characteristic dumb-bell crystals will be seen. These patients do not seem specially liable to form stones.

The *treatment* consists in altering the diet and treating the indigestion. Large quantities of fluid and of boiled water should be taken and the general health improved in every possible way. Large doses of acid sodium phosphate are said to prevent the formation of the crystals.

STONE IN THE URETER

Stones are not infrequently found impacted in the ureter, and though in a very few instances they may have been formed in this situation above a stricture, upon a scar or in connection with a foreign body, such as a ligature, nearly every ureteric calculus has been formed in the kidney and passed down into the ureter. Impaction usually occurs at three places :—

(*a*) About 2 inches from the top of the ureter.

(*b*) In the neighbourhood of the pelvic brim.

(*c*) Within 1½ inches of the opening into the bladder. Sometimes the stone actually will protrude from this opening into the bladder.

Usually there is only one stone, which is round or ovoid, somewhat resembling a date stone. Uric acid stones are seldom seen in the ureter, calcium oxalate or phosphates usually being the constituents, for these latter stones are far less smooth, and therefore more liable to be held up in the ureteric lumen.

It must be remembered that many stones pass down from the kidney to the bladder without becoming impacted, and that a stone only will become wedged if it is rough and spiky, or as a result of spasm or swelling of the mucous membrane. When impaction occurs, in some instances the ureter is there and then completely blocked. If this happens, urinary secretion on that side stops and the kidney will atrophy slowly ; this is important in connection with calculous anuria (see p. 841) More commonly, however, the impaction of a stone only blocks the ureter incompletely, or it may be that the calculus acts more or less as a ball valve, and lets the urine pass intermittently. When either of these conditions is present a hydronephrosis will be formed, and this probably will lead to a pyonephrosis after a time.

It often happens that the ureter above the stone becomes dilated, sometimes even reaching an inch in diameter, and considerable inflammation and thickening of the ureteric wall and the surrounding tissues will occur, while at the site of impaction the mucous membrane frequently becomes ulcerated. This leads to the formation of scar tissue, which may cause a stricture of the ureter to develop either before or after the stone is removed (see p. 847).

In other instances the ulceration may pass right through the ureteric wall and give rise to peritonitis, retroperitoneal cellulitis, or extravasation of urine. Once a stone is impacted in the ureter it will often continue to increase slowly in size.

Clinical Features. This condition gives rise to signs and symptoms which are very similar to those of renal calculus, and consist of pain, aching and hæmaturia. When the stone is passing down the ureter and becoming impacted, severe ureteric colic will occur, the pain being even worse than in renal colic, situated lower down and less in the back, and radiating even more definitely into the testicle and groin. If the pain is lower at each subsequent attack, it is highly suggestive of a stone passing down the ureter, and each attack of colic will probably be followed by hæmaturia. When a stone is reaching the lower end of the ureter and nearing the bladder, it often will give rise to great frequency and strangury (*i.e.*, frequent painful attempts at micturition, during which very little is passed). Once a stone is finally impacted it may be symptomless, though even then it often will give rise to attacks of colic at long intervals.

A ureteric stone sometimes may be palpated; in thin patients at times it may be felt through the abdominal wall, while when it is low down in the pelvis it often will be palpable from the rectum or vagina.

In the diagnosis of this condition X-rays, cystoscopy, and the other methods of renal investigation play an essential part. A good X-ray film will show the condition at once, but if a shadow is seen approximately in the line of the ureter care must be taken in interpreting it, for there are many other conditions which give rise to very similar shadows ; thus phleboliths, calcified retroperitoneal or mesenteric glands, fæcal concretions, appendix concretions, or patches of atheroma in large vessels all may be deceptive. It should be remembered, however, that the shadows of ureteric calculi are always elongated, always have their long axis vertical, and lie exactly in the line of the ureter. Should there be any doubt, a catheter which is opaque to X-rays is passed up the ureter; this will either hitch against the stone or pass by it. In either case an X-ray photograph is then taken, and the shadows of stone and catheter will be stereoscopically in contact.

Cystoscopy often will show a change in the ureteric mouth. The stone sometimes will be seen sticking out of the mouth, or the mouth may be red, congested, patent and round, or swollen and œdematous.

Changes in the urine may be present, and albumen, pus or blood may be discovered. In all cases the renal efficiency in both kidneys must be tested.

Treatment. Unless the condition known as calculous anuria (see below) is present there is no grave urgency in operating upon a stone which is recently impacted in the ureter, and it is quite justifiable to wait a few weeks to see if subsequent attacks of colic will cause the stone to drop into the bladder. Rough-walled and spiky stones are less likely to pass than round or smooth ones, while the passage will be assisted by plenty of fluids to drink and the administration of urinary antiseptics and atropin to allay spasm.

If the stone is within 2 or 3 inches of the bladder, it is sometimes possible to dislodge it by passing a catheter up the ureter, when the stone may come down in the next few days. A little sterile oil or oil and novocaine can be injected into the ureter by this means, and this may help the stone to pass.

If, however, a stone has been immovably fixed for four or five weeks, operation should not be delayed any longer, as otherwise the kidney is certain to suffer, while the risk of ureteric stricture and calculous anuria always must be remembered.

The method employed for operative removal of a stone in the ureter will depend entirely upon the situation of the stone. If the stone is sticking out through the ureteric mouth into the bladder, it usually can be detached and set free by means of a small pair of forceps passed up an operating cystoscope, while the ureteric mouth even may be slit open a little with scissors or a diathermy electrode passed up the same instrument.

If these methods fail, the ureter must be exposed by one of the methods described on p. 856; the stone is removed, the ureter sutured with catgut, and a small drain left down to it for a few days. If advanced hydronephrosis, pyelonephritis or pyonephrosis are present, the kidney had better be removed.

Calculous Anuria. This is a rare condition where, as the result of a calculus suddenly becoming impacted in a ureter and blocking it, complete and absolute suppression of urine occurs instantaneously on both sides, the patient passing none whatever. The condition is naturally exceedingly grave, as fatal uræmia is bound to set in in the course of a few days.

This state of affairs can occur only in the following circumstances:—

(*a*) One kidney already has been destroyed more or less completely by previous disease, when a calculus suddenly blocks the other ureter. The previous disease may be tuberculosis, growth, septic infection, etc., but is most likely to have been caused by other calculi. Possibly one ureter is already blocked when the other suddenly undergoes the same process. Very rarely a simultaneous blockage of both ureters by descending stones has occurred.

(*b*) One kidney may have been congenitally absent or have been removed previously, when the other ureter suddenly becomes blocked by a calculus.

(*c*) One ureter suddenly may become blocked by a calculus and the function of the other kidney may be completely suppressed reflexly.

(*d*) One kidney may be completely out of action for any of the above causes, and then, as the result of calculi in the other one, a sudden attack of acute pyelonephritis puts an end to its secretion of urine.

Such a condition of anuria rarely will come on suddenly in a patient who appears to be well. More commonly it is preceded by renal pain on one or both sides, and often by a long-standing history of renal disease. The anuria may set in absolutely suddenly or may be preceded by a few days during which small quantities of pale urine are passed. In other instances there is frequency, strangury or difficulty of micturition, while sometimes a preliminary short polyuria will occur. Middle-aged and gouty men are those most commonly affected.

The recently obstructed kidney becomes very congested, purple and large. It will frequently show a shadow on an X-ray film and this may be a useful observation in showing which kidney has been obstructed last.

The symptoms of uræmia will supervene, but often not for seven or eight days after the last urine was passed, this being known as the "tolerant period"; when they set in they consist in vomiting, tremors, twitchings, abdominal distension, constipation, drowsiness, etc., leading to fits and convulsions, as described on p. 816. Coma and œdema are rarely seen in this variety of uræmia, and death usually occurs from cardiac failure. Once uræmia has set in death usually occurs in two or three days.

It is of the greatest importance to discover which of the two kidneys is the one to be put out of action last, *i.e.*, has its ureter blocked, for this is the one which is more likely to recover, and is therefore the one to which treatment should be directed as soon as possible. Thus the side on which colic has last occurred, and on which most pain, tenderness and rigidity are present, is more likely to be the recently affected one. Cystoscopy will be of help in these cases, for by passing a catheter the stone may be detected, while if an hour or two can be spared an X-ray photograph will be valuable.

It is important to make certain that the condition is not one of anuria due to other causes, such as a chronic double pyelonephritis, or blocking of both ureters due to a pelvic tumour, such as a uterine carcinoma.

Treatment. The general and medical treatment for uræmia should be applied at once, while operation to relieve the obstruction should be performed as soon as possible, and this should be done upon that kidney which is thought to be the one last put out of action. This is usually the side on which pain has last occurred, while an X-ray photograph may help (see above). It is not advisable to endeavour to search for and remove the stone in the ureter, as the simplest and shortest procedure should be undertaken. The kidney is cut down upon, incised, and a drain inserted into its pelvis, while the offending stone is left until another day, when the patient is better, unless it obviously presents itself. If on performing this operation it is found that this kidney is completely destroyed by previous disease, or that it is not obstructed, the opposite kidney must be exposed at once and the same procedure adopted. In many instances the urine will start to flow again at once and the patient be saved, while treatment will then have to be undertaken for the stone in the ureter.

TUBERCULOSIS OF THE KIDNEY

Tuberculosis of the kidney is nearly always at some stage of its course accompanied by tuberculous infection of other parts of the genito-urinary tract, such as the bladder, prostate, vesicles or testicles. It is, therefore, really in most instances part of a genito-urinary tuberculosis, and we are here considering chiefly the renal aspect.

In nearly every case of tuberculous kidney tuberculous foci are present elsewhere in the body, if not in the genito-urinary system, at any rate in the glands or the lungs, though these other foci are frequently latent and unsuspected.

Several different pathological varieties of the disease are seen :—

(1) Acute miliary tuberculosis of the kidney sometimes occurs. This is part of a generalised tuberculosis, both organs are studded with tubercles, and there is no treatment, as the condition is hopeless.

(2) Many cases are seen in which the disease appears to be primary in the kidney. Frequently, however, the bladder or other parts of the tract will be involved, and it is, therefore, difficult to say whether the bladder is secondary to kidney or the kidney to the bladder. It is most probable in all instances that the infection reaches the kidney via the blood stream, while it is not common in these cases for both kidneys to be involved. This is the type of disease with which we are really concerned here. It tends to remain confined to the one kidney for a considerable time, while the organ is ultimately destroyed. It is most common in young adult males.

(3) It is a remarkable thing that when the kidney is infected through the blood stream the disease is nearly always unilateral in the early stages, but instances are sometimes seen where both kidneys become involved more or less simultaneously and secondarily to a primary focus lower in the urogenital system. This is especially common in young adult men where the primary focus is in the epididymis, and the prostate, bladder, and both kidneys may become involved.

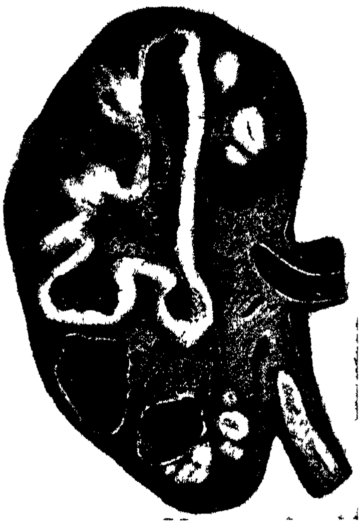


FIG. 282. Tuberculous kidney of the ulcerocavernous type.

In all forms of the disease the pathological changes are roughly the same and are described below.

Pathology. In the early stages the disease is usually unilateral, the tips of one or more pyramids being frequently first affected, usually one of those near the upper pole of the kidney. These become ulcerated, so that they lose their pointed shape and become broadened. Granulation tissue is formed and eats into the renal substance, while caseous foci arise and break down, so that the pyramid is converted into a wedge-shaped caseous mass, often with little tubercles around it. It is sometimes found that tuberculous deposits occur in the cortex, which caseate and break down to form abscesses. These also track towards the pelvis, so that in both forms the pelvis soon becomes involved, its mucous membrane becoming red and congested, thickened and ulcerated.

Simultaneously with the involvement of the pelvis, a further destruction and erosion of the renal substance occurs, the process being one of spreading ulceration with granulation tissue formation and caseation. The kidney tends to become eaten out into a series of caseating hollow spaces all communicating with the pelvis and having a very characteristic appearance, sometimes called the *ulcerocavernous form.* Tubercles will be seen elsewhere in the renal cortex, while the kidney gradually increases in size, its surface becoming bumpy or bossy, with purple patches on it. As the caseation within proceeds, it leads to hollowing of the organ together with enlargement, and this form is sometimes known as a *tuberculous pyonephrosis.* Sooner or later a septic infection will become superadded, while in some instances the organ becomes enormously enlarged, hard, bossy, and full of abscess cavities.

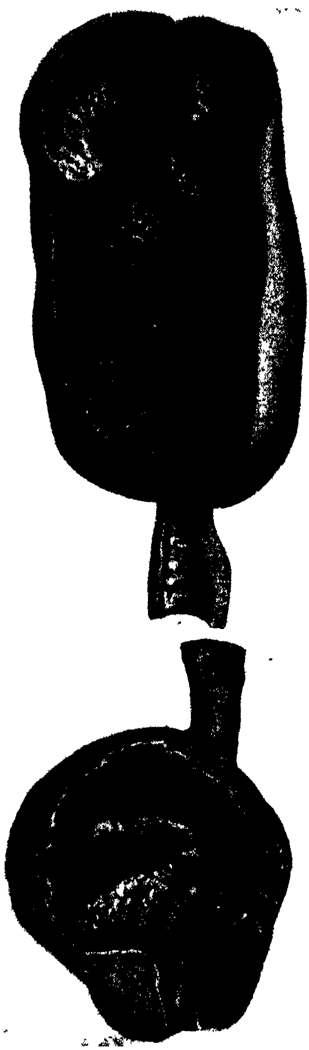


Fig. 283. Tuberculous pyonephrosis with advanced tuberculous cystitis and ureteritis.

Very soon changes in the ureter supervene, its mucous membrane becomes red, œdematous and ulcerated, and its walls thickened and hard. The lumen becomes full of caseous débris and pus and may be blocked completely. After the disease has been present for some time, the ureter becomes scarred, fibrosed and shortened, so that its opening into the bladder may be dragged up, or laterally displaced (see p. 845).

Changes also occur in the tissues around the kidney and ureters, where the chronic inflammation leads to infiltration, thickening and fibrosis. The kidney and ureter thus become fixed and adherent to surrounding structures, such as the peritoneum, spleen or colon. Sooner or later infection also sets in in the prostate or testicles in the male.

In some instances, as the result of cortical abscesses rupturing externally, perirenal infection and abscess formation will occur. This is usually seen late in the disease, so that the perirenal abscess probably will contain a mixed assortment of organisms, such as B. coli, cocci, and B. tuberculosis.

The passage of pus, caseous débris and organisms down the ureter sooner or later will lead to tuberculous infection of the bladder, and this process always commences first round the mouth of the infected ureter.

Occasionally a diffuse calcification will occur within a very chronic tuberculous kidney, and lead to a deposit of soft, calcareous matter which may cast a shadow in an X-ray film.

Clinical Features. This disease is less common in women than in men, and is usually seen in young adults. The initial symptoms are often vague, and may be referred to either the kidney or the bladder. The progress is often slow, and it may take three years or more for the kidney to become completely disorganised.

The commonest first symptom of which the patient complains is frequency, micturition being required about every half-hour, and often being painful. This frequency is not due to cystitis in the early stages, for no inflammation of the bladder is then present, and it must be regarded as resulting from polyuria due to a reflex process set up by the diseased kidney or by the urine being unusually irritating. The sudden onset of a causeless frequency in a young adult, especially if the urine is acid, is thus gravely suspicious. At this stage there may be no detectable change in the urine, but on cystoscopy the ureteric mouth on the affected side may be red and swollen.

Other cases will complain only of a painless hæmaturia, while the third group present themselves complaining of a dull aching pain in the kidney region. Sooner or later, as a rule, all three symptoms of frequency, hæmaturia and pain appear. They are none of them relieved by rest and are often worst at night, in which they differ greatly from the symptoms of a calculus. The aching pain is dull and often constant, but exacerbations resembling colic are sometimes seen as a result of semisolid caseous material finding its way into the ureter. In some instances pain is complained of also in the bladder, perineum and penis, especially during micturition.

After a time an evening temperature will set in, accompanied by night sweats, malaise and loss of weight, and the patient may pass into a characteristic tuberculous toxæmia.

On palpation of the kidney in the early stages nothing abnormal will be noticed, but as the disease becomes more advanced tenderness and ultimately enlargement will be detectable. In some cases a large renal tumour will be found, but it must be remembered that at times the healthy kidney is larger than the diseased one as a result of doing the work of the two.

Examination of the urine is of the greatest importance, for it may contain albumen, pus or blood, but frequently these constituents are absent for some time. It is nearly always acid, and polyuria is often present. Careful examination must be made for tubercle bacilli, and this is done by centrifuging and staining a twenty-four hours' specimen of the urine. The organisms are nearly always present in this disease, except in the earliest stages, though it must be remembered that some patients who have phthisis and normal kidneys, nevertheless, will excrete tubercle bacilli in their urine. Repeated examinations and the use of a guinea-pig may be necessary to demonstrate them. The ultimate diagnosis rests almost entirely upon cystoscopy and urinary investigation, while it must be remembered that the whole of the genito-urinary tract must be searched to see if the disease is present elsewhere, the testicles, prostate and bladder being enquired into specially. In moderately advanced cases, a hard, thickened, cord-like ureter may sometimes be felt on rectal or vaginal examination. Enlargement of the epididymis or nodules in the prostate may be felt, while *cystoscopy* usually will give most valuable information.

Thus, firstly, tuberculous cystitis may be seen with its characteristic features (see p. 869). Secondly, on observing the mouth of the suspected ureter, characteristic changes are often present; thus redness, congestion and pouting, superficial ulceration, or one or two small tubercles in the immediate neighbourhood of the ureteric mouth are almost diagnostic, while in cases of older standing the orifice may be puckered, retracted, displaced outwards, or round and patent, looking like a black hole. In addition to this, catheters must be passed up both ureters that the urines may be collected separately, and examined both for the presence of tubercle bacilli and for the general renal efficiency. This is essential in order to make certain that there is no tuberculosis of the other kidney. It may show also how far the disease has advanced. The importance of obtaining the efficiency of the opposite kidney and of feeling assured that it is free from disease will be realised when it is remembered that nephrectomy probably will be the treatment required.

An X-ray photograph is often valuable; this may show a definite calculus, in which case tuberculosis is not likely to be present. On the other hand, diffuse calcareous areas or a large caseating kidney sometimes may be visible; either of these are highly suggestive of tuberculosis.

In advanced stages the condition of the patient becomes miserable, but the most unpleasant symptoms are now due to the tuberculous cystitis rather than to the kidney (see p. 869). In these later stages the thickened and hard ureter always can be felt on rectal or vaginal examination.

If pyogenic infection becomes superadded upon either the kidney or bladder condition, the disease spreads more rapidly and the patient soon goes downhill. The temperature, which is not often much raised while the condition is purely tuberculous, becomes high, swinging and hectic, while a perinephric abscess is likely to form. In untreated cases or cases in which treatment has failed, death will occur, but often not until after some years of ill-health; it is due either to uræmia, general tuberculosis or exhaustion from lardaceous disease and toxæmia.

Treatment. The treatment of choice is undoubtedly removal of the kidney, but it is by no means feasible in every case. Thus it can be undertaken only if the disease is confined to one kidney, so that careful investigation of the other kidney is essential. The presence of tuberculosis in the bladder, prostate or even testicle is no contra-indication to a nephrectomy combined, if necessary, with orchidectomy; for if this is done the lesions in the bladder and prostate frequently will clear up under general treatment, though the prognosis is naturally worse. The presence of phthisis is a contra-indication to the removal of a tuberculous kidney, as the chest condition is the more serious and the more urgent. Other tuberculous foci, such as joints or glands, may or may not contra-indicate nephrectomy; each case must be judged on its own merits, remembering that it is not wise to remove a tuberculous kidney if another and more serious tuberculous lesion is present elsewhere.

In a suitable case, the sooner after the diagnosis is made the nephrectomy is performed the better. Lumbar nephrectomy is best, and as well as removing the kidney, the fatty tissue round it should be excised also, while as much of the ureter as possible should be removed. In order to remove the full length of the ureter, a separate incision above Poupart's ligament should be made (see p. 856), where the tube can be exposed and tied in two places. Pure carbolic is injected between the two ligatures, the ureter cut across and brought out of the upper wound by dragging it up with the kidney. Partial resection of the kidney or scraping or curetting are not advised. Care must be taken not to tear the kidney, and no incision must be made into it, or tuberculous material will be let out into the surrounding tissues. The wound should be sutured without drainage, and healing by first intention is nearly always obtained.

If for any reason nephrectomy is impossible, there is still a possibility of the patient's ultimate recovery, provided he is put under adequate treatment. This consists in open-air treatment in a suitable climate, satisfactory dieting and injections of tuberculin. This latter remedy seems to be especially valuable in genito-urinary tuberculosis. Under this treatment it sometimes happens that the kidney becomes quiescent and fibrosed.

With regard to the prognosis, in early cases where one kidney only is involved and the bladder appears normal on cystoscopy with the exception of the ureteric mouth, nephrectomy is almost certain to produce a cure. The prognosis is also good in those cases where the ureter is blocked and a large tuberculous pyonephrosis is present. If the bladder, vesiculæ and prostate are involved extensively, nephrectomy does not offer so good a chance.

Stricture of the Ureter. This is not a common condition, but it is occasionally seen as a result of ulceration following impaction of a stone or after healing of tuberculous or other infections of the tube. Abdominal and gynæcological operations occasionally produce this condition as a result of injury. The symptoms consist of ill-defined pain and occasional attacks of ureteric colic, while pus, blood or albumen may be present in the urine. The most important feature is, however, that in the course of a few weeks or months a unilateral hydronephrosis will form. Cystoscopy, the passage of a ureteric catheter, and the distension of the ureter with sodium iodide solution, followed by an X-ray photograph (see p. 810), will settle the diagnosis.

Treatment. In most cases this can be satisfactorily accomplished by the passage up the cystoscope of bougies of increasing size. In some instances the presence of the stricture is unsuspected until an operation is performed for the removal of a ureteric stone, when the stricture is either seen or the wound will refuse to heal and a urinary fistula form. In this case the best treatment is resection of the affected portion of the ureter followed either by anastomosis of the severed ends, or, better still, by a transposition of the upper end of the ureter into a separate opening in the bladder wall (see p. 855).

Syphilis of the Kidney. Very occasionally a gumma is seen in the kidney, which then breaks down and undergoes caseation. A painless enlargement occurs with occasional hæmaturia but no pyuria, so that the condition is probably mistaken for tuberculosis.

A diffuse interstitial fibrosis of the kidney is also occasionally seen as the result of syphilis; this will resemble a new growth. Both these conditions usually undergo nephrectomy before the diagnosis is made.

TUMOURS OF THE KIDNEY AND URETER

(A) *Innocent Tumours.* These are very rare. Occasionally a *fibroma* or *adenoma* of the renal substance occurs, but they do not reach any large size and are quite symptomless, usually being encountered accidentally either at operation or in the post-mortem room.

Papilloma of the Renal Pelvis. This is perhaps the commonest form of innocent tumour, but it is distinctly rare. It gives rise to a villous columnar-celled papilliferous tumour growing within the pelvis of the kidney, exactly similar to the type of papilloma seen in the bladder, while similar growths are very rarely seen in the ureter or at its lower end. Though described as innocent, these growths, in common with the papillomata seen in the bladder, are very near the border line of malignancy, for implantation growths and recurrences after removal are common: metastases are not formed.

The condition is only seen in adults, in whom it gives rise to hæmaturia as practically the only symptom. If clots or pieces of growth, however, pass down the ureter, pain and renal colic may be caused. Sooner or later infection or stone formation may occur, and then albuminuria and pyuria will be present. A secondary hydronephrosis or pyonephrosis is liable to supervene. Implantation deposits of growth occur down the ureter or in the bladder as the result of implantation of loose particles of the original tumour, but the condition does not give rise to distant metastases and is not really malignant. Cystoscopy will show merely blood coming down from one ureter, though a portion of the growth may be seen projecting from the ureteric mouth. A more exact diagnosis usually cannot be made, though a few cases have been demonstrated by means of a pyelogram, when a " filling defect " may be seen in the shadow of the renal pelvis. However, as unilateral hæmaturia demands exploration of the kidney, the growth will be discovered thus. After being present for some time there is a tendency for these growths to become definitely malignant ; when one is discovered a nephrectomy, therefore, should be performed.

Angioma of the Renal Pelvis. This is a rare condition found occasionally in the renal pelvis. The only symptom is a painless hæmaturia, which must be localised to one or other kidney by cystoscopy. This may be most profuse and dangerous. It then demands an exploration of the kidney. A local excision (papillectomy), coagulation by the electrocautery, or a nephrectomy should be performed according to circumstances.

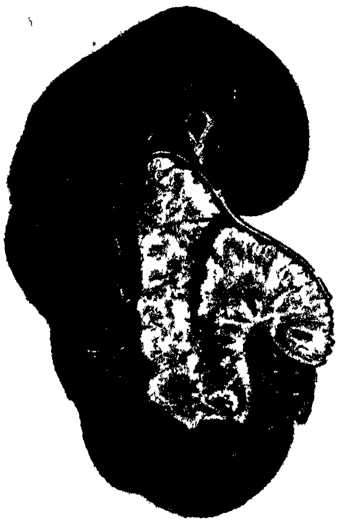


FIG. 284. Extensive papilloma of the renal pelvis

(B) *Malignant Tumours.* The majority of renal growths are malignant, and the kidney, in common with the testicle and other structures morphologically associated with these organs, exhibits a series of malignant growths which do not fall quite into line with malignant growths seen elsewhere in the body. Carcinoma, sarcoma, hypernephroma, endothelioma, and embryoma or teratoma are all described, but it is quite possible that all these growths really are varieties of embryomata in which one or other of the different primary tissues are predominant.

(1) **Renal Sarcoma of Infants (Wilms's Tumour).** This is a not uncommon type of sarcoma which may be congenital or appear within the first three years of life. It is a spindle-celled and mixed-celled sarcoma with a fairly definite capsule, and contains tissues resembling cartilage or striped muscle fibres. It grows very rapidly and is at times in its later stages bilateral, while if congenital it may obstruct delivery. Metastases form rapidly and life is soon destroyed by sarcomatous emboli travelling freely about the body. Many pathologists regard it as a teratoma.

(2) **Renal sarcoma of adults** is much less common. These tumours are spindle-celled, but often contain mixed tissues. They grow rapidly and only involve one kidney, while they are sometimes accompanied by calculi : they probably commence in the renal capsule. This capsule soon becomes broken through, and diffuse secondary deposits are early and extensive.

(3) **Carcinoma of the kidney** is rare and atypical. It occurs in adults, in whom it gives rise to a rapidly growing enlargement of the kidney. It is

difficult to classify it under any particular microscopic type of carcinoma, as it contains such varying structures. It resembles a hypernephroma, but has a more definite supporting fibrous framework, the columnar cells being arranged into definite alveoli. It spreads by the lymphatics.

(4) **Hypernephroma.** This is the commonest type of renal tumour and represents about 70 per cent. of all renal growths. It is sometimes known as the "adrenal tumour of Grawitz." This tumour is usually seen arising in the cortex of the kidney and at the upper pole, immediately beneath the capsule; though it was thought that it might take its origin either in the suprarenal gland itself or in isolated rests of adrenal substance lying concealed in the top of the kidney, probably it is true carcinoma of the renal tubules, and this is now the more generally accepted theory.

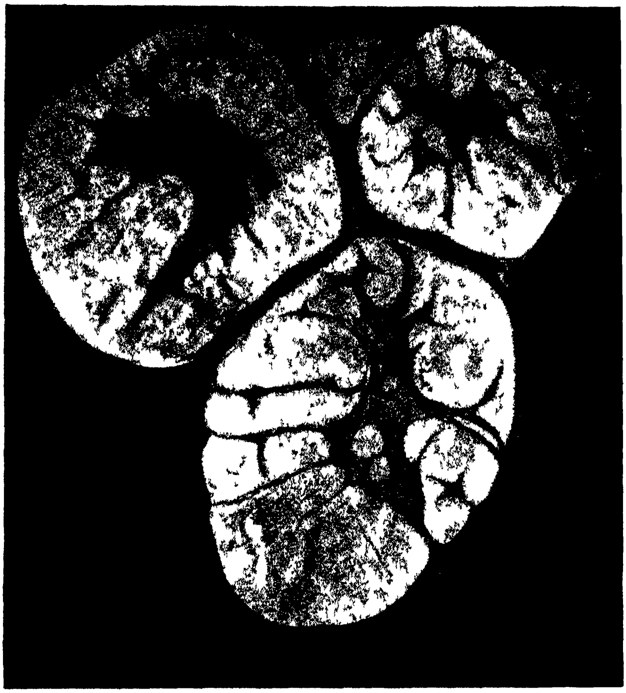


FIG. 285. Sarcoma of the kidney.

The tumour starts as a localised growth which projects from the upper half of the kidney with a bossy surface, rapidly increasing in size and encroaching on the kidney substance and pelvis. It is usually hard and solid, but after a time cystic degeneration and hæmorrhages occur within it, accompanied by areas of necrosis. A clearly defined capsule is present, so that the kidney substance is at first pushed aside rather than invaded ; later, however, it will become invaded. Though the colour of the other malignant growths of the kidney is whitish and brain-like, a hypernephroma is a peculiar golden yellow (the "golden tumour"), thought to be due to the deposit within it of a peculiar type of fat. It is striated and has many coarse semi-transparent septa of fibrous tissue which render it mesh-like, while it contains many areas of red or maroon colour, which are rounded and localised and probably due to hæmorrhages. Microscopically the growth closely resembles the structure of the zona fasciculata of the suprarenal body, consisting of densely packed columns of polyhedral glycogen-containing cells. Sooner or later it will fungate into the pelvis.

These growths may lie dormant for years, may grow slowly, or may be very malignant in type, and give rise to metastases which are conveyed all over the body chiefly by the blood stream. These metastases show a special tendency to involve the bones, and sometimes the metastases appear and give rise to symptoms before the primary growth is noticed.

Hypernephromata are usually seen in patients over the age of fifty, and though they may appear to grow slowly for a time, they inevitably destroy life.

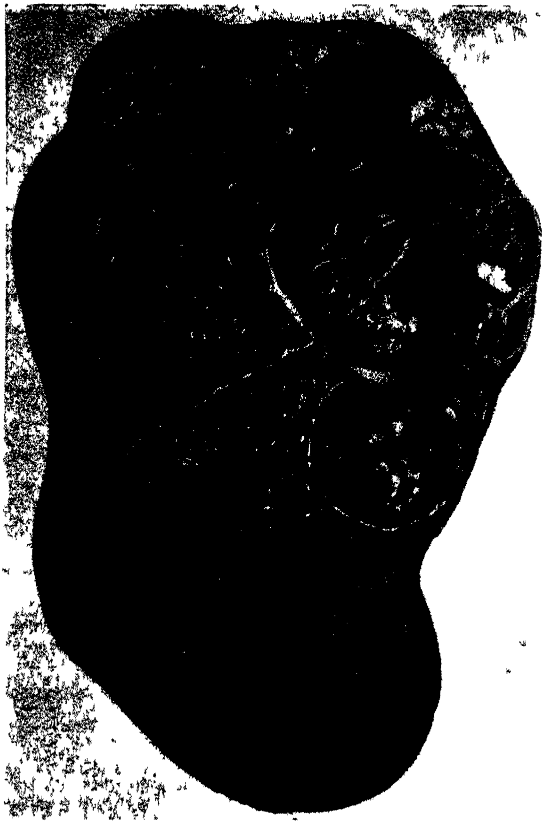


FIG. 286. Large hypernephroma occupying the top half of the kidney.

All these malignant tumours of the kidney tend to perforate their capsule and invade the perirenal tissues, while the growth often spreads along in a solid column of cells inside the renal vein to the inferior vena cava, where pieces get broken off and carried about in the blood stream as emboli so that metastases are frequently met with in the lungs, showing as typical cannon-ball tumours in X-ray films, and in the long bones. They have no special tendency to invade the lymphatic glands, except in the case of the rare carcinomata.

Clinical Features. The signs and symptoms of all malignant renal growths may be described as hæmaturia, pain, and the presence of a characteristic renal swelling.

(*a*) *Hæmaturia* is practically never seen in the renal sarcoma of infants, but is common in renal sarcoma of adults, carcinoma and hypernephroma. In many cases it does not occur until the tumour is advanced and has broken into the pelvis. It is generally painless, spontaneous, and is usually intermittent. Worm-like clots are seen, while the urine is often of port wine colour. It may be preceded for some weeks by a polyuria of low specific gravity.

Painless hæmaturia, especially in an adult, always should be regarded as a most grave symptom, demanding the earliest and most searching investigation. Whichever kidney it comes from should be explored.

(*b*) *Pain* may be of three kinds, a persistent aching pain due to the presence of the growth, renal colic due to the passage of clots and particles of growth. and referred pain when the growth is advanced and involving surrounding nerves and structures. Pain seems to be absent in the renal sarcoma of infants, and is most marked in carcinoma and hypernephroma.

(*c*) A characteristic *renal swelling* in the loin is often the first and only sign present. It is the only symptom in the renal sarcoma of infants, where it is often not noticed until it is huge. In adults it may need careful examination to detect it, and when the growth is at the upper end of the kidney, such a tumour may be very difficult to feel. It is hard, bossy and irregular, moves up and down well with respiration at first, but later becomes fixed.

A very suggestive feature which is not uncommonly seen is the appearance of a varicocele in an adult. Though a spontaneous varicocele is common on the left side, where it has no significance, its appearance on the right side is strongly suggestive of a renal growth. It is due to the pressure of the tumour upon the spermatic vein. Such a varicocele which is due to a renal tumour does not disappear on lying down in contrast to the ordinary spontaneous type.

In the latter stages, failure of health, loss of weight, anæmia and toxæmia, sometimes accompanied by fever, will set in.

Cystoscopy will demonstrate the blood coming from one ureter, while the presence and satisfactory functioning of the opposite kidney must be ascertained ; there is no pus or organisms in the urine. The presence of a growth in one kidney often appears to set up a chronic nephritis in the other kidney. possibly as the result of toxæmia and excretion of toxic substances.

In renal tumours usually an X-ray photograph with uroselectan shows no filling or excretion of fluid but an ascending pyelogram will generally show a filling defect.

The following table will give an indication of the main differences in the symptoms of the various types of malignant renal tumour :

	Sarcoma of Infants.	Hypernephroma.	Sarcoma and Carcinoma of Adults
Age . .	1–3 years.	45–60	Over 40.
Tumour . .	Huge.	Large.	Small.
Hæmaturia .	Very rare.	Present in recurrent attacks.	Continuous.
Pain . .	Apparently none.	Aching marked.	Very severe.
Metastases .	Common, especially in opposite kidney.	Late—in bones, lungs and liver.	Early.
Duration of life	Up to 5 months.	Up to 5 years.	1 year.

Treatment. Provided no secondary deposits are present, this consists in nephrectomy, the fatty tissue round the kidney being removed together with the organ. If the tumour is at all large, this had better be done by means of transperitoneal nephrectomy, as it may not be possible to remove it by the lumbar route. The operation is often very difficult on account of adhesions. The function of the other kidney naturally must be investigated.

In infants, again, nephrectomy is the only treatment, but it is not often possible and the mortality is high. In these cases recurrence is almost inevitable, while, though in many adult instances the patient survives the operation, recurrence is exceedingly likely within the next year.

Tumours of the Suprarenal Body. A few cases of tumours of the suprarenal bodies have been described (either adenomata or simple hyperplasia) which have been associated with striking sexual changes, always in the direction of increased masculinity. Thus a boy with such a condition becomes early developed and precociously male (the " infant Hercules " type), while girls become masculine in type (*virilism*). The girl may develop a deep voice, grow hair on her body, and behave like a man. After removal of such tumours the condition has passed off, and the girl changed to the female type. These growths if unilateral may be approached surgically either by laparotomy or, better, through the lower and back part of the chest by incising the diaphragm if necessary, though often a high lumbar kidney incision suffices as the adrenal mass displaces the kidney downwards.

Those cases with bilateral hyperplasia of the adrenal cortex, which is often associated with a pituitary adenoma, are not suitable subjects for operation, but improvement may occur following deep X-ray therapy of the pituitary fossa and loins.

CYSTS OF THE KIDNEY

Solitary cysts are occasionally seen in the kidney, but they are rare. They usually lie in the cortex near the capsule at the upper end, and bulge out into the perirenal tissues, at times becoming very large. Their cause is unknown. They may be the result of cystic degeneration of some form of embryonic germinal tissue, but more likely are due to some congenital obstruction of certain tubules of the kidney. The fluid they contain is thin and watery, with a small amount of albumen and salts, while the condition is usually seen in middle-aged women.

There are, as a rule, no symptoms, and unless large enough to be palpable they will not be recognised except at operation or in the post-mortem room ; in any case, if palpable they are most likely to be diagnosed as hydronephroses.

When discovered at operation, the best treatment is to excise the cyst with a small amount of surrounding renal tissue, if possible ; the bleeding is stopped easily by sutures. Failing this, the outer walls of the cyst should be cut away and the cavity packed with gauze in order that it may heal up slowly by granulations.

It is possible that some of these cysts are of lymphatic origin.

A hydatid cyst is occasionally seen in the kidney. It gives rise to no symptoms other than a palpable swelling, while if it is old-standing and calcified the swelling may be hard and craggy. We know of one case where such a cyst in a man of about sixty was thought to be a carcinoma of the stomach. Occasionally the cyst bursts into the pelvis and renal colic is set up by daughter-cysts passing down the ureter. The only treatment feasible, as a rule, is nephrectomy.

Dermoid cysts and *multiple small cysts* developing generally as the result of chronic interstitial nephritis are occasionally seen.

Congenital Cystic Kidney (Polycystoma, Polycystic Kidney). This is a rather less rare condition, where one or both kidneys slowly become converted into a large number of round cysts. Congenital cases are nearly always bilateral, but it is possible that a few unilateral instances are acquired. The kidney becomes enlarged to many times its proper size, while its surface becomes bumpy or bossy, the whole of its secreting tissue being honeycombed with hundreds of cysts of any size up to that of a grape. They may communicate with one another, but do not communicate with the pelvis, and are full of a straw-coloured or blood-stained fluid, usually containing urea or cholesterin. As the disease progresses a considerable degree of atrophy and fibrosis is set up around the cysts and the condition is usually far more advanced in one kidney than in the other. It is not infrequent for the condition to show a familial tendency and to find both the liver and the spleen also converted into a honeycomb of multiple cysts, while the pelvis of the kidney is unaffected. Hypertrophy of the left side of the heart occurs, together with a high blood pressure and general arteriosclerosis.

The cause of the condition is unknown, though there are several theories as to its origin. Thus it may be some peculiar form of new growth which is cystic from the first, such as a cystadenoma, while an alternative theory is that it is due to a congenital lack of fusion and junction between the glomeruli and tubules of the kidney, so that the former become dilated from obstruction. It may be due to a persistence of the Wolffian body which later undergoes cystic degeneration; while another theory states that the cysts are large retention cysts, secondary to the fibrosis of the kidney. Misshapen or malplaced kidneys are more liable to the disease than normal organs.

Clinical Features. The disease is most insidious and may be present for years without symptoms. It is very rare for it to be discovered before the age of forty. Two groups of symptoms may occur :- firstly, the presence of a large, knobbly, bossy mobile renal tumour on one or both sides, accompanied perhaps by a dragging or sense of pain in the loin; while the other group are entirely due to the onset of renal failure from the destruction of the kidney tissue produced. Thus there will be polyuria, headache, thirst, signs of a high blood pressure, and a dry brown tongue, with flatulence and vomiting, or palpitation and breathlessness. Hæmaturia occasionally has been described, sometimes with colic, while in a few instances fatal uræmia has set in without warning.

The kidney, though much enlarged and bossy, retains its approximate shape and is often abnormally mobile.

The urine is usually increased in amount, pale, of low specific gravity, with a little albumen and a few casts. Some observers have described a characteristic body in the urine rather resembling the corpora amylacea seen in the prostate. In infants, the tumour has at times been big enough to obstruct delivery.

Treatment. This is very unsatisfactory, for as the condition is nearly always bilateral, no operation, such as nephrectomy, which in any way will diminish the amount of active renal tissue, must ever be undertaken. Rovsing has described an operation which consists in drawing the kidney into the loin and puncturing as many of the cysts as possible and letting out the fluid. The second kidney may be done at a later date. This reduces the size of the kidney and relieves pain, but is occasionally followed by a urinary fistula. Otherwise the treatment is entirely medical, and is that of chronic interstitial nephritis in general.

B. coli and Parasites in the Urinary Tract. The whole urinary tract is often infected by bacillus coli, which, though it occasionally gets in through the urethra (see p. 899), is more commonly conveyed by means of the blood or lymph stream from some small lesion in the bowel. In many cases this gives rise to a characteristic cystitis or pyelitis, which are described on their appropriate pages, but it is not uncommon, especially in women and children, to find a pure **bacilluria** present without any actual inflammation of the lining of the tract. This may last for days or months and give rise often to very few signs and symptoms locally, other than frequency and irritation of the bladder. Rigors and very high fever sometimes occur, and in children the condition may resemble typhoid or meningitis. The condition may arise spontaneously in persons apparently healthy, while dirtiness, constipation, worms and phimosis are common predisposing causes. The urine contains no pus or albumen, is acid (soon becoming alkaline on standing), and opalescent, while on microscopy it is teeming with B. coli, either singly or in clumps.

Treatment. This consists in keeping the urine alkaline by means of citrate or bicarbonate of potash, giving sulphanilamides, and providing the patient with plenty of bland fluids to drink. Any discoverable cause should be removed, while if the condition does not clear up soon and tends to become chronic, an autogenous vaccine and ketogenic diet, with mandelic acid treatment (see p. 867), will be of great benefit.

The **Bilharzia hæmatobia** is most commonly met with in the urinary tract, especially in the bladder. Its life history and clinical course are described in Ch. VI., Vol. I., the female burying herself in the submucous tissues of the urinary tract. The ova with their sharp points pass down the ureter to the bladder, causing pain and hæmaturia, while ulcers and granulations appear on the mucous membrane, which becomes greatly overgrown. The urinary symptoms and treatment are further discussed on p. 882.

Filaria sanguinis hominis is occasionally found in the urinary tract (see also Vol. I., Ch. VI.). It will give rise then to hæmaturia and chyluria, the urine looking milky with streaks of blood in it.

Essential Hæmaturia. This is a somewhat uncommon condition in which a profuse intermittent painless hæmaturia occurs, demonstrated by means of the cystoscope to be coming from one kidney only. (It should be remembered that if the cystoscope shows blood coming down both ureters we are probably dealing with a blood disease or with congenital cystic kidneys.) This name is only given to the condition when no cause can be found in the kidney to account for the hæmorrhage; thus, before making this diagnosis it is essential to exclude calculus, growths, tuberculosis and other infections of the kidney, while it should be remembered that in some cases the cause lies in a high blood pressure, general arteriosclerosis, or chronic nephritis. In some instances, while the bleeding is progressing, severe pain resembling renal colic will be present, probably due to clots passing down the ureter.

In all these instances an exploration of the kidney will be necessary, and if the diagnosis is correct nothing will be found, even upon splitting the kidney. A portion of the kidney should be removed for microscopy. Strangely enough, this operation of exploring the kidney, even when nothing is found, nearly always cures the hæmorrhage.

OPERATIONS UPON THE KIDNEY AND URETER

Methods of Exposing the Kidney. Two main methods of exposing the kidney are employed: (*a*) From the back, and (*b*) from the abdomen.

(*a*) *Lumbar Methods.* Two lumbar incisions are commonly employed for reaching the kidney by a retroperitoneal route.

To perform these lumbar incisions the patient is placed in a special position. He lies upon his sound side with the upper arm supported on an arm rest. A sandbag, cylindrical air cushion or special elevated metal bar fixed on the operating table passes across beneath him just below the costal margin to separate the gap between the lower ribs and the iliac crest on the side to be operated upon. The underneath knee and hip are flexed up, while the upper knee and hip are straight, and the patient is propped in this position by means of sandbags.

(1) *The Oblique Incision.* This commences at the outer border of the erector spinæ and passes downwards and forwards parallel to and ½ inch below the last rib. It may be carried forwards to the flank and on to the abdomen parallel to the fibres of the external oblique as far as is necessary. The aponeurosis of the latissimus dorsi and some of its muscular fibres are divided, the lumbar fascia and the posterior portions of the abdominal muscles are split. The erector spinæ and quadratus lumborum are not damaged but are retracted towards the spine. At the top of the incision a few fibres of the arcuate ligament may be cut, and here care must be taken not to open the pleura. Some surgeons always make a practice of removing the last rib—this usually is not necessary.

The perirenal fat is then exposed and incised, the kidney sought for and gently brought up into the wound. The assistant should press on the abdominal wall in order to push the kidney up into the wound.

(2) *The Vertical Incision of Edebohl's and Mayo.* This starts in the angle between the erector spinæ and the last rib and runs vertically downwards just inside the outer border of the erector spinæ to the iliac crest. Here, if necessary, a prolongation outwards of an inch may be made. The sheath of the erector spinæ is opened and the muscle retracted inwards, while the lumbar aponeurosis is divided and a part of the aponeurosis of the latissimus dorsi. No muscles are cut, the erector spinæ and the quadratus lumborum being retracted backwards and the abdominal muscles dragged forwards. The perirenal fat is then exposed and opened as before.

(*b*) *The Abdominal Method.* Transperitoneal exposure of the kidney is not often performed, but is a very simple method. The abdomen is opened, usually by means of a paramedian incision, the intestines are packed aside and the peritoneum of the posterior abdominal wall incised vertically immediately outside the ascending or descending colon, as the case may be; there is then no chance of damaging the blood supply of the colon. The kidney is easily found and brought into the wound.

A similar method may be employed if necessary without opening the peritoneum, this layer being carefully stripped at the front, side and back of the abdomen until the kidney is reached.

This method of exposure of the kidney is rarely employed except for the removal of large renal growths, and it should not be used if the kidney is thought to be infected. If a large tumour is present the peritoneum is usually pushed so far inwards and forwards that there is no need to open it.

Exposure of the Ureter. This will depend entirely upon which part of the ureter is to be exposed. The ureter is usually more easily found if a bougie is first of all passed up it and left there during the operation.

(*a*) *The Upper Part of the Ureter above the Iliac Crest.* This is exposed easily by either of the lumbar incisions for exposing the kidney described above. A slight prolongation of the incision may be necessary, the kidney is discovered and the ureter traced down from it.

(*b*) *The Pelvic Portion of the Ureter.* The pelvic portion of the ureter down to the point where it enters the bladder is best reached through the retroperitoneal tissues. The incision may be either a vertical one in the midline immediately above the bladder or one parallel to and about half an inch

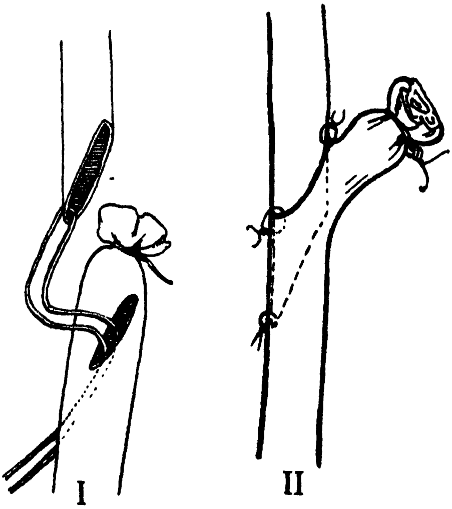


FIG. 287. Van Hook's method of joining a divided ureter.

above the outer half of Poupart's ligament. The various layers of the abdominal wall are incised until the peritoneum is reached. This is not opened but is stripped upwards by means of pads of gauze, the line of the external iliac artery being followed. On reaching the division of the common iliac artery the ureter will be discovered. It will not be lying upon the vessel but will be adherent to the back of the peritoneum, together with which structure it is lifted up. The patient should be placed in the Trendelenburg position for these operations.

After opening the ureter to remove a stone, etc., the opening should be sutured carefully with catgut and a small drain left in, reaching down to the incision for forty-eight hours.

(*c*) In women the last 2 inches of the ureter may be reached per vaginam, through the lateral fornix.

(*d*) An older method of exposing the ureter (the "parasacral method"), by dividing the fibres of the gluteus maximus and the great sacrosciatic ligament, is seldom practised now.

(*e*) *The Intravesical Portion of the Ureter.* The portion of the ureter within the bladder wall (about ¾ inch) may be reached through the above incision. It is, however, better dealt with by opening the bladder suprapubically and incising the mouth of the ureter. Small stones and growths sometimes may be removed from this situation without any external incision by means of the operating cystoscope.

(*f*) *Transperitoneal Exposure of the Ureter.* This may be done at any part of the course of the tube. As, however, this is always liable to give rise to infection inside the peritoneum, the extra-peritoneal operations are safer.

For methods of suturing, anastomosing, resecting and transplanting the ureter, reference must be made to books on operative surgery.

Nephropexy (Nephrorrhaphy). This is the operation employed for fixing the kidney in place when it is abnormally movable. The kidney is exposed by either of the lumbar incisions described above, preferably the vertical one. The organ is then brought up into the wound and carefully freed from fat, together with its pedicle. It is by no means as easy to fix the kidney permanently as might be expected, and several different methods have been devised. Thus the wound down to the kidney may be left partially open and packed with gauze, so that granulations and adhesions may form ; this is, however, not advisable. Secondly, strong catgut stitches may be passed right through the renal substance and through the lumbar muscles, especially the quadratus lumborum ; the top stitch if necessary may be passed above the last rib. In performing this operation it is of the greatest advantage to strip the fibrous capsule off the kidney, at any rate for the half if not for the whole of its surface, while some surgeons prefer to sling a portion of this reflected capsule over the last rib. If silk or salmon gut stitches are employed for this purpose they must be brought out through the skin and tied externally so that they can be removed in three weeks.

After this operation the patient must be kept flat on her back in bed for at least three weeks, while it is not wise to fix both kidneys on the same day.

Nephrolithotomy and Pyelolithotomy. These are the two operations undertaken for the removal of a stone from the kidney.

The kidney is exposed and brought into the wound through either of the two lumbar incisions described above. It is cleansed as carefully as possible from the fatty tissue so that it can be brought right up to the surface of the skin. If a considerable degree of pyelonephritis or infection is present this may be a difficult proceeding, as the kidney will be adherent and the pedicle fibrosed and shortened. The kidney, ureter and pelvis must then be carefully palpated to ascertain where the stone is. If it cannot be felt the organ should be needled, as this often may demonstrate it. If even this fails to discover it, the kidney should be split along its convex border for about half its length in a line slightly posterior to its middle plane and in its lower half (the bloodless plane of Hyrtl). A calyx may then be opened, the finger introduced and the pelvis and the kidney substance explored. In many cases to find a small stone in the kidney substance, the greater part of the kidney may have to be split in this way, the plane behind the middle one being selected, as this is the most bloodless site. While the kidney is being split the assistant should squeeze the renal pedicle with his fingers or with special forceps to control the hæmorrhage. This operation of incising the kidney to remove a stone is known as *nephrolithotomy*. Before the kidney is opened the tissues round must be packed off carefully with sterile gauze. When the stone is removed the incision in the kidney is tightly sutured with interrupted catgut stitches passed deeply through the kidney substance almost down to the pelvis on a big round curved needle and tied over the convex surface of the kidney, but before this is done the ureter should be examined thoroughly with a probe or sound to make sure no further stones are present. These through-and-through stitches will stop the bleeding; if they are not sufficient a few mattress sutures may be added.

It is hardly ever necessary to drain the kidney or its pelvis unless gross infection is present, as a renal sinus is liable to form. When the tissues are, however, infected, it is wise to put a tube down to the kidney when it is replaced in its bed, for forty-eight hours.

If the stone is obviously lying in the pelvis of the kidney and does not appear to send ramifications far into the kidney substance, it may be removed by opening the kidney pelvis without incising the kidney itself (*pyelolithotomy*). An incision is made in the back of the pelvis, the stone removed, the rest of the kidney explored with the finger and the incision in its pelvis closely sutured with catgut; a small graft of perirenal fat may be sutured over this. Drainage of the kidney pelvis should not be employed, and unless gross infection is present the wound should be sutured completely.

Large, soft or branched stones may be difficult to remove. Special stone forceps and scoops should be employed.

In many cases of renal calculus the kidney will be found to be so disorganised that a nephrectomy is necessary. This may prove a most formidable operation.

Nephrectomy. This is the operation of removal of the kidney. Needless to say, before it is done very careful examination of the affected kidney must be made to ascertain if removal is justifiable, while care must be taken to ascertain that the other kidney is present and functioning sufficiently well to carry on the excretion of urine. Nephrectomy may be necessary for injuries, such as rupture of the kidney or ureter, for growths, hydronephrosis or tuberculous kidney, for hæmorrhage following other kidney operations and for pyonephrosis and cases of calculus where infection and marked destruction of renal substance have occurred. The operation may be very easy or exceedingly difficult. It is especially in cases of pyonephrosis and old-standing kidney infections that difficulties occur owing to the size and adherence of the organ. In these cases it may sometimes be wiser :—

(*a*) To drain the kidney for ten days or a fortnight, for this may render excision easier ; or

(*b*) Deliberately to strip the true kidney capsule off the organ and remove it from within its capsule, leaving the latter behind (intracapsular nephrectomy).

(A) Lumbar Nephrectomy. This is the best method in general as the peritoneum is not opened. It should be employed always if it is thought that the kidney is infected or that pus is present. On the other hand, in the case of very large renal swellings, such as growths, hydronephroses, etc., the gap between the last rib and the crest of the ilium may not be sufficient to get the kidney out.

One of the two lumbar incisions already described is employed; the kidney is brought into the wound and carefully cleaned, together with its pedicle. The ureter is exposed, ligatured in two places ½ inch apart and a drop or two of pure carbolic acid injected into it between the ligatures with a hypodermic syringe to sterilise it. It is then cut between the ligatures and the renal pedicle is tied. Strong silk should be employed, and it is well to ligature the artery and veins separately. The wound is then closed usually without drainage. This may be a most difficult operation if the kidney is adherent and the pedicle is short and stiff.

If any doubt exists as to the condition of the other kidney the peritoneum may be opened, the hand introduced and the opposite kidney palpated, while in this way other abdominal organs may be examined.

The ureter also can be removed by means of this operation if the incision is prolonged downwards and inwards. This is advisable in the case of tuberculous kidney, and here the total length of the ureter can if desired be excised. The kidney is exposed and its pedicle cut, as above described, the ureter not being sectioned. The wound is then stitched up completely, the kidney hanging attached only by the ureter which passes into the depths of the wound. A second incision is then made above Poupart's ligament, and the ureter exposed in the depths of the pelvis, tied and cut, being sterilised by carbolic first. On pulling sharply on the kidney it will then be found that the whole length of the ureter can be dragged out of the wound.

(B) Transperitoneal Nephrectomy. This should be avoided if it is thought that the kidney is infected. In the case, however, of large renal tumours, growths and hydronephroses, it provides a very much easier method of removing the organ. It is sometimes possible to avoid opening the peritoneum, but, in our opinion, it is simpler and better to do this deliberately. The abdomen is opened on the required side by a long paramedian incision, the small intestine is packed over to the opposite side, an incision is made in the peritoneum of the posterior abdominal wall to the outer side of the ascending or descending colon, as the case may be, and the colon, together with the vessels supplying it with blood, is stripped up towards the middle line. The kidney is then exposed and stripped from its surrounding tissues. Care must be taken of the aorta, the splenic vessels, the duodenum and the inferior vena cava, for it may be adherent to any of these structures. The kidney is then lifted up, and its pedicle and the ureter exposed, these structures being dealt with as already described above. The kidney is then removed. If drainage is required, which is not likely, it should be effected by a separate stab incision through the loin. The colon is then dropped into place and fixed with a few stitches if necessary while the abdominal wound is closed.

The After-Treatment of Operations on the Kidney. This does not differ greatly from other abdominal operations. It must be remembered that these operations may give rise to great shock and pain, and therefore it is wise to give the patient morphia afterwards. Careful watch must be kept for some days following the operation to see that the excretion of urine is satisfactory, especially if one kidney has been removed, while hæmorrhage down the ureter is liable to occur. The patient, therefore, should be given large quantities of fluids, water, lemonade, barley water, imperial drink, Contrexéville, tea and coffee being among the best; while meat and nitrogenous foods must be avoided for some days. After any operation on the kidney it is wise to put the patient on a mixture of urotropin and acid sodium phosphate.

Secondary hæmorrhage is fairly common after any operation in which the kidney has been opened; if it occurs it nearly always demands prompt removal of the kidney.

THE BLADDER

Congenital Malformations. (*a*) Very occasionally a *persistence of the urachus* is met with. This structure is the remnant of the primitive allantois, and normally consists of a fibrous cord passing in the extraperitoneal fat from the bladder to the umbilicus. If it persists it will give rise to an escape of urine from the umbilicus in the new-born child. The condition is easily cured by operation, but it must be remembered that it usually is accompanied by some form of urethral obstruction, which must be put right. Operation, however, should not be undertaken until the child is at least several months old. The top of the bladder is exposed by a median suprapubic incision, the urachus is discovered, tied off from the bladder and dissected away, up to the umbilicus. At times only the bottom portion of the urachus is patent; this then forms a diverticulum of the bladder, in which a stone may form.

An even more rare condition which is hardly ever seen is due to the persistence of the primitive cloaca, so that the bladder may open into the rectum or vagina.

Allantoic cysts (*urachal cysts*) are sometimes seen between the bladder and the umbilicus, and are due to patency of the central portion of the urachus. They should be removed, as malignant disease sometimes commences in their walls.

Carcinoma of the urachus is occasionally seen. It is either a squamous or columnar growth, usually the latter, and often with colloid degeneration. This gives rise to a large, round, hard tumour fixed at the top of the bladder. After a prolonged period it ulcerates through into the apex of the bladder, where it causes hæmaturia and cystitis, and may be seen with the cystoscope. Previous to this it is usually symptomless. These growths must be excised freely with the upper half of the bladder and the linea alba and cellular tissues up to the umbilicus. They are of a low grade of malignancy.

Other growths of the urachus are occasionally seen. These may be fibro-adenoma, sarcoma and fibroma. They all tend to resemble rectal growths.

(*b*) **Extroversion of the Bladder (Ectopia Vesicæ).** This is also a rare condition where there is a total absence of the anterior and lower wall of the bladder and of the lower portion of the anterior abdominal wall; there is a gap in the pubic symphysis, which is practically non-developed, the pubic bones coming to an end on either side in the inguinal region. This is due to a gross lack of development of the whole lower part of the abdomen, the two lateral halves of which it is formed failing completely to unite. As a result of this the posterior wall of the bladder with its mucous membrane is pushed forwards by the abdominal contents behind it, and it projects in the middle line below the navel as a red rounded swelling about 1 inch in diameter, covered with a rough and irregular mucous membrane on which may be ulcers, excoriations or hæmorrhages. This swelling moves to and fro on respiration, and is partially reducible on pressure. At the lower part of this tumour there may be seen the openings of the two ureters from which the urine is ejected at intervals. Around the area of mucous membrane and where it meets the skin is a thick band of scar tissue.

FIG. 288. Ectopia vesicæ.

In addition to this the pelvis is deformed and the innominate bones and hips are rotated outwards so that the gait is ugly and waddling. In some cases the testes are undescended, while at birth it occasionally happens that the prolapsed bladder is covered by the lower portion of the umbilical cord, which is representing a portion of the allantois. When the cord sloughs the bladder base becomes exposed. In the male, in whom it is more common, the penis is always rudimentary and is split open upon the dorsal surface into a gutter, which is continuous with the bladder mucous membrane. This condition is known as **epispadias** (see p. 894). The penis is often drawn up over the trigone.

The urine is continually running away, and the clothing is always wet, while the skin of the abdomen and thighs becomes red and sore, and this, together with the rubbing of the clothing against the sensitive exposed bladder mucous membrane, gives rise to very great discomfort. There is always a great tendency to ascending infection of the kidneys and pyelitis. It is not likely, therefore, that the subjects of this distressing condition will live to a great age. Apart from the discomfort of the urinary flow, in adults complete impotence is present, which naturally has an additional marked psychical effect on the patient.

Treatment. This in the past has been most unsatisfactory. In some instances the fitting of a portable urinal has given relief, but these are difficult to fashion and awkward to fit.

Many operations have been devised in an attempt to form a new anterior wall for the bladder. They are mostly unsatisfactory, as no sphincteric control can be provided.

In the female it may be possible to transplant the bladder mucous membrane and ureters into the vagina, while the vulva is almost completely closed, so that the vagina may form a reservoir. Other methods consist in an attempt to implant the ureters together with an area of surrounding bladder mucous membrane, or practically the whole of the trigone, into the rectum or pelvic colon, which will act as a reservoir and contain the urine for several hours (Maydl). In other cases an isolated and excluded portion of intestine has been used for this purpose.

Probably the best treatment for this condition is to transplant the ureters into the pelvic colon; they must be made to traverse the bowel wall under the mucous membrane for an inch or so before they actually enter the bowel lumen on the lines rather of a Witzel gastrostomy, as this may prevent ascending infection. The two ureters should be transplanted on different days with an interval of at least three weeks between the two operations. The proceeding is done entirely inside the peritoneum. A recent series of cases by Grey Turner, in which both ureters have been transplanted into the wall of the colon in this way so as to make a more or less valvular opening, has proved how successful the operation can be, as many of these cases have been most satisfactory, though there is always a risk of ascending infection of the kidneys. Control is soon learnt, and the bowel will contain the urine for several hours. The operation should not be done until the child is five years old, and it is probably better to do the right ureter first. At a later date further operations may be undertaken to reform the urethra with a view to regaining sexual potency.

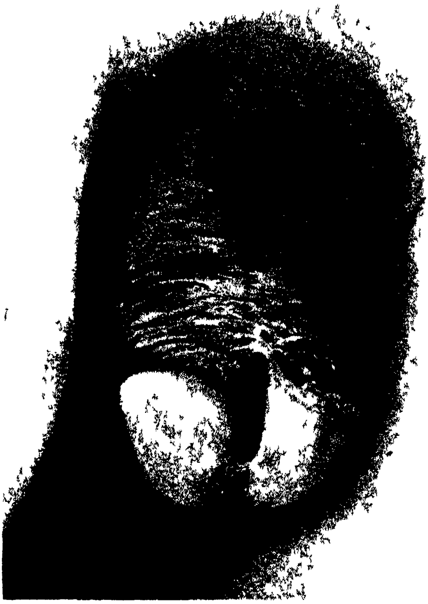


FIG. 289. Epispadias, in which a partial plastic operation has been performed.

An alternative method which is useful in adults is to bring the ureters out on to the skin in the loins and provide a proper collecting apparatus.

There are many older operations which are most unsatisfactory. Trendelenburg practised a section of the sacro-iliac ligaments at the back to allow the pubic symphysis to be brought together, so that the bladder wall was pushed inwards. Various plastic operations and skin flaps have been devised, but a fatal objection to all these methods is that the skin of the lower abdominal wall, when turned in to line the bladder, develops a big growth of pubic hair, which soon becomes encrusted with phosphates.

Hernia of the Bladder. This is described on p. 563.

Rupture of the Bladder. This is a not uncommon injury usually met with in adult males. It is most unlikely to occur unless the bladder is full, when it may be due to blows, kicks, crushes or falls on the lower part of the abdomen. In fractures of the pelvis the bladder, especially at its neck, is often torn or penetrated by a spicule of bone, and here it may not necessarily be full. Gunshot wounds of the bladder are common in war-time. They are frequently complicated by other injuries to the abdominal contents. It is possible that rupture occasionally occurs from simple over-distension of a bladder which is trabeculated, ulcerated or otherwise diseased, while catheterisation or washing out of the organ occasionally has produced this lesion. Two forms of rupture of the bladder are described, the intraperitoneal and the extraperitoneal.

(*a*) **Intraperitoneal Rupture.** This has already been described on p. 526. It is usually the result of a blow on the lower part of the abdomen, which produces a tear high up in the posterior wall, so that the urine escapes into the peritoneum. Urgent operation is necessary.

(*b*) **Extraperitoneal Rupture.** This is less common. The bladder gives way on its anterior wall or at its base, so that the urine escapes not into the peritoneum, but into the pelvic cellular tissues and the cave of Retzius. This form of rupture is produced in two ways. Most commonly it is the result of fracture of the pelvis, when the anterior wall near the neck of the bladder is torn. In other instances the over-distended bladder is ruptured by a direct blow upon its anterior surface, so that the rupture is rather higher up. In either case the extravasation of urine rapidly leads to a virulent pelvic cellulitis, and the extravasation spreads up deep to the muscles in the anterior abdominal wall towards the navel and round to the sides of the bladder and rectum. Where the triangular ligament is torn, as often happens when the pelvis is fractured, the urine escapes into the perineum and skin of the scrotum and penis as in extravasation from ruptured urethra (p. 895). It does not get into the thighs, nor back to the ischiorectal fossæ, being limited by the attachments of the fascia of Scarpa and of Colles. In a few days suppuration will occur and abscesses will point, while the patient rapidly becomes toxic and desperately ill. The extravasation sometimes may be felt in the early stages on rectal examination (see p. 896).

As in the case of intraperitoneal rupture, this condition frequently occurs in drunken persons whose bladders are distended, while it is not infrequently overlooked as shock is very slight. The patient's chief complaint is of hypogastric pain and inability to pass water, while on catheterisation little will be obtained save a few drops of blood-stained fluid. Extraperitoneal rupture is even more deceptive than intraperitoneal rupture, though the presence of blood in any urine that can be obtained, and of an increasing swelling in the neighbourhood of the bladder, should raise strong suspicions.

In every case of fractured pelvis the presence of an injury to the bladder or urethra should be looked for.

Treatment. Extravasated urine must be let out, and the hole in the bladder closed by operation as soon as possible. Of these two objects the first is the more important, and the second may be impossible. Free incisions, therefore, should be made wherever the extravasation is appearing. This may be necessary in the perineum, but is more commonly required in the suprapubic region. In the latter case the bladder should be opened suprapubically and the injury sutured if possible. The extravasated areas are washed out with warm saline and tubes introduced, one into the bladder to drain it, and several into the areas where the urine has been extravasated. The length of time these tubes remain in will depend on how rapidly the condition settles down and granulations and fibrous tissue form. Drainage is likely to be necessary, however, for at least five or six days. It must be remembered that at times the rupture in the bladder is both intra- and extraperitoneal.

Wounds of the Bladder. Gunshot wounds of the bladder are common in military practice, while stabs from pointed objects are occasionally seen. Injuries during the course of pelvic or hernia operations sometimes occur, while occasionally on opening the lower abdomen a careless surgeon will open the bladder. There is no excuse for this, as it is the operator's business to ascertain that the bladder has been emptied. In the case of gunshot wounds it must be remembered that the entry may be anywhere in the abdomen, buttock, perineum or thigh.

The clinical symptoms are exactly the same as those due to intraperitoneal or extraperitoneal rupture of the bladder, in addition to the external wound by which blood-stained urine may escape. The possibility of two or more wounds in the bladder must be remembered. Recovery sometimes will occur from these injuries even if untreated, the external wound permitting the urine to escape, when a urinary fistula is likely to form.

Treatment. This is exactly the same as in the case of rupture of the bladder. In the case of an extraperitoneal wound, if the wound is laid open and the bladder drained through it by means of a tube, complete recovery probably will occur. In all these cases the administration of urinary antiseptics must be continued for some weeks afterwards.

Foreign Bodies in the Bladder. Foreign bodies introduced into the bladder from without are by no means uncommon. Portions of catheters, lithotrites, cystoscopes and rubber tubing occasionally have broken or dropped off and been left in the bladder, while patients sometimes introduce such foreign bodies as hairpins, slate pencils, knitting needles, etc. This is naturally more easy and common in the female. It is done by children probably as the result of curiosity, and by adults with a view to stimulating sexual feeling—two very similar instincts. Another group of foreign bodies occasionally seen are pathological objects, such as gall-stones, which have ulcerated through the gall-bladder, sequestra from the pelvic bones, hair or teeth from pelvic dermoids, etc.

These foreign bodies soon become covered with a phosphatic deposit and give rise to a chronic cystitis, to which most of the symptoms are due, though if the object is pointed or sharp, pain, hæmaturia and strangury may be caused. In time they become converted into a phosphatic stone. The symptoms are almost entirely those of chronic cystitis (see p. 866), and the onset of an apparently causeless cystitis should always raise the suspicion that a foreign body is present. Naturally the patient is not likely to give a history of it. Occasionally such foreign bodies are half buried in the bladder wall.

The diagnosis of the condition rests entirely upon the cystoscope and X-ray film, either or both of which methods will show the presence of a foreign body and give an indication as to its size and how to remove it.

Treatment. This consists in removing the foreign body as soon as possible, and the method of doing so will depend upon its size and shape. In the female small foreign bodies may be drawn down the urethra through a speculum with forceps, though it is wise not to stretch the female urethra too much, or incontinence will follow. In other cases the lithotrite will be valuable to crush or cut the body up, but if the body is big or irregular in shape it will have to be removed by a suprapubic opening of the bladder. This need not be followed by drainage unless very obvious cystitis is present.

CYSTITIS

Cystitis or inflammation of the bladder is a common condition due to many different causes and organisms. With the exception of a few cases due to strong antiseptics or chemicals, all other cases are infective in origin. The causative organisms which are usually present are one or more of the following varieties: B. coli, staphylococci, streptococci, B. typhosus, B. tuberculosis, pneumococci, gonococci or B. proteus, while certain other organisms are sometimes present which decompose urea. There is nearly always a mixed infection, the B. coli and staphylococci being by far the commonest. Some of these organisms have the power of making the urine alkaline, such as the staphylococci, B. proteus, streptococci and B. typhosus, while others are only found with an acid urine, namely, B. coli, the gonococcus and B. tuberculosis. If the urine becomes alkaline and ammoniacal, it is irritating to the bladder mucous membrane, while phosphates are deposited and tend to form a stone if any obstruction to free exit from the bladder exists.

It must be remembered, however, that bacteria can be continually present in the urine and bladder and that pus may descend from the kidney for long periods without causing any detectable cystitis, unless some other factor favouring its development is present. This local predisposing factor may be of several varieties.

(*a*) Probably the most important additional feature is any form of retention of urine or difficulty in completely emptying the bladder at micturition, *e.g.*, calculus, enlarged prostate, stricture, congestion of the mucous membrane, etc. This applies with even greater force to those diseases and injuries of the nervous system and spinal cord which interfere with the function of the bladder and prevent its being completely emptied. In this case there also may be a trophic influence at work upon the mucous membrane. Whatever precautions are taken to sterilise the penis, urethra, catheters, etc., in these cases of spinal injury or disease, cystitis is almost certain to set in sooner or later, and it, together with its renal complications, may prove the factor which kills the patient.

In women a cystocele, or in either sex the presence of a diverticulum, often forms a nidus in which the organisms may develop.

(*b*) Any form of congestion of the bladder mucous membrane. This may follow sexual excess, excess of alcohol, exposure to cold (indeed, there are some people who appear to take cold in their bladders rather than in their nose or throat), and the taking of certain irritating drugs, such as cantharides, cubebs, copaiba or other diuretics. Slight degrees of bruising or injury of the bladder mucous membrane, as after passing a catheter, may precipitate infection.

(*c*) The presence of foreign or irritating material in the bladder. This includes such conditions as foreign bodies, calculus, growths of the bladder or excess of urinary salts and crystals, while injury to the bladder wall will come also into this category on account of bleeding.

(*d*) Certain changes in the urine, such as are seen in diabetes and chronic renal disease, seem to exhibit a tendency to cause cystitis.

Bacteria cause inflammation of the bladder, both by direct infection of the bladder mucous membrane and also by producing certain changes in the urine. The routes by which they reach the bladder are several.

(1) By far the commonest is by means of the urethra. Normally the urethra is sterile, but in many diseased conditions it becomes infected, and then the organisms are likely to pass up to the bladder. The passage of urethral instruments naturally will assist this greatly, as also will the short and large urethra of the woman as compared with the long and narrow one of the male. Cystitis is therefore much more common in women, in whom it frequently occurs secondarily to a vulvovaginitis or dirty and inflammatory conditions round the anus and perineum; also in connection with labour and the puerperium. Infection undoubtedly spreads up the urethra to the bladder by means of the periurethral lymphatics at times.

(2) In many instances the organisms pass down in the urine from the kidney, though, as already stated, this may continue for years without infection supervening. Infection of the bladder secondary to the kidney will occur also by the lymphatics.

(3) Bacteria sometimes reach the bladder via the lymphatics from infection of neighbouring organs or from the bursting of abscesses, etc., into the bladder. Even this latter process sometimes will occur without cystitis supervening. It is probable that in many cases B. coli reach the bladder by direct spread through the walls of the colon.

Inflammation in the bladder may be acute or chronic, the changes in the bladder and the clinical features differing considerably in the two conditions.

Pathological Changes. (*a*) *Acute Cystitis.* Here the whole mucous membrane of the bladder becomes acutely red and congested, while all the changes are most marked in the region of the base and neck of the bladder. The normal bladder mucous membrane when seen with the cystoscope is pale and yellowish, but in acute cystitis it becomes brilliant red or crimson. Small hæmorrhages occur, the mucous membrane becomes sodden and thickened, and the epithelium is sometimes raised into bullæ (bullous cystitis); more often it is shed so as to give rise to superficial ulcers. Mucus, or rather muco-pus, is secreted, and flakes of pus and fibrin will be seen sticking to the surface of the bladder wall, and in a few instances minute abscesses appear all over the bladder mucous membrane. In more severe instances necrosis or gangrene of large parts, or even of the whole of the mucous membrane, occurs, and it is shed in sloughs, while sometimes a membranous inflammation occurs and large pieces of fibrinous membrane are passed. There is very little change in the muscle and other layers of the bladder wall in acute cystitis.

(*b*) *Chronic Cystitis.* In chronic cystitis the muscle and other portions of the bladder wall become involved as well as the mucous membrane, while the condition is in no sense confined to the neck or base of the bladder. The mucous membrane is thickened, but less congested than in the acute state, being of a grey or bluish colour, roughened and velvety, and with vessels visible in it. Small hæmorrhages, granulation tissue and a somewhat deeper form of ulceration occur, while all over the bladder wall will be seen an evil-smelling deposit of phosphates, fibrin, mucus and pus.

The muscle wall becomes hypertrophied and tends to become trabeculated and arranged into bands and bundles which form an interlacing network between which the mucous membrane bulges out in the form of pouches or diverticula. This is especially the case where urinary obstruction is present. In these pouches phosphates are liable to be deposited to form stones. In a few instances the chronic ulceration which occurs deepens and progresses so that perforation may supervene and give rise either to peritonitis or pelvic cellulitis.

In other instances, where chronic cystitis has been present for a long time, the bladder wall becomes so hypertrophied, thickened, fibrosed and contracted, that the bladder contracts down and can contain only an ounce or two of urine, being unable to stretch to any greater degree. This is often seen in tuberculous cystitis. Such a contracted bladder drags the peritoneum down with it and disappears behind the pubes, so that it may be quite difficult to find at operation.

It must not be forgotten that as a result of these bladder changes the onset of ascending pyelonephritis, or pyonephrosis and the formation of renal calculus is highly likely in one or both kidneys, while chronic cystitis is extremely likely in time to lead to the formation of stone in the bladder.

Clinical Features. (*a*) *Acute Cystitis.* The chief symptoms are intense irritability of the bladder with spasmodic contractions, which are set up directly a small amount of urine is present. This gives rise to great frequency and pain on micturition which may be agonising, while the symptom of urgency is very marked, though only small quantities of water, which are often blood-stained, are passed each time (strangury). In addition to this there is a more or less continuous pain of an aching or burning nature in the perineum and hypogastrium, occasionally also at the tip of the penis ; there is tenderness immediately above the pubes and across the lower abdomen. Sleep is impossible, and the patient gets very exhausted.

The temperature is usually slightly raised, while shivering and vomiting are sometimes seen ; tenesmus from irritation of the rectum sometimes sets in. High fever always suggests the likelihood of a renal infection having supervened.

The urine contains blood, pus, albumen and bacteria, while hæmorrhage occasionally is very profuse. In addition, many flakes of fibrin and débris consisting of sloughing epithelium will be present. It usually becomes alkaline and ammoniacal, in which case the pus forms a semitranslucent sticky mass at the bottom of the vessel. In an acid urine, on the other hand, the pus floats about all through the specimen.

In most cases, with proper treatment the condition settles down completely, though chronic cystitis supervenes at times. In the very severe cases in which gangrene of the mucous membrane occurs, the urine is particularly brown, foul, and contains large shreds of mucous membrane. In these cases death may occur from exhaustion, peritonitis or toxæmia.

Acute cystitis is seen most commonly in women, in whom it may occur as a primary condition. In men, however, it is more usually the result of some other pre-existing condition in the bladder, such as a growth or stone.

Treatment. It is never wise to cystoscope a patient while acute cystitis is present. She should be confined to bed with the foot of the bed raised, while hot fomentations are applied to the hypogastrium and perineum. The painful bladder spasms will be relieved by hot enemata and by lying and soaking in hot hip baths for as long as possible, and in addition to this large doses of tincture of hyoscyamus and suppositories of belladonna and morphia should be given to allay the irritation, while heroin or morphia hypodermically may be necessary to secure rest. Only fluids should be given by the mouth, and large quantities of barley water, tea, milk and water and Vichy and Contrexéville may be given. Whatever the reaction of the urine is, it should be altered by drugs ; thus if it is highly acid, potassium citrate, lithia water and sodium bicarbonate are useful ; if alkaline, acid sodium phosphate and hexamine must be given, while salol and boric acid are useful. The bowels must be kept open by saline purgatives. Sandalwood oil is sometimes valuable, as also is benzoic acid. In most instances under this treatment the condition will commence to settle down in four or five days.

In very severe cases which do not show any improvement under this treatment, and where there seems to be danger of the infection ascending to the kidneys, or if the urine is very foul and shreds of mucous membrane are present in it, drainage of the bladder should be performed by the suprapubic route. Washing out of the bladder is to be avoided while the condition is acute. The patient should continue to take large quantities of fluids for some weeks afterwards.

(*b*) *Chronic Cystitis.* This is much more common, and is usually accompanied by some other condition, such as stricture, enlarged prostate, calculus, new growths or foreign bodies. In these cases the symptoms develop gradually and insidiously, while they sometimes follow upon an attack of acute cystitis. In many cases, however, there are very few symptoms, the only change noticed being the presence of pus in the urine. This pus may come and go, but exacerbations will occur at intervals when there is irritability of the bladder, frequency, especially at night, and slight pain. The urine contains mucus, muco-pus, or pus with epithelial cells and many organisms. It is usually alkaline and ammoniacal, thick and contains a granular deposit of phosphates. It must be remembered that ulceration or calculus formation often will occur as secondary changes with their corresponding symptoms. After a time the patient's general health becomes affected from absorption of toxins and exhaustion from nocturnal frequency, while there is always a considerable risk at any time of ascending renal infection developing and giving rise to pyelonephritis. This is especially likely to occur if the urine is alkaline or any obstruction to its outflow is present. The presence of shivering, rigors, or rise of temperature is highly suggestive that pyelonephritis has already commenced. It must be remembered that in many such cases the pus may be coming from the kidney or the urethra and not from the bladder, or as well as from the bladder.

To complete the diagnosis a microscopical and bacteriological examination of the urine must be made therefore, always remembering the possibility of tuberculosis being present, while a two-glass test and a cystoscopy should be performed to ascertain where the pus is coming from.

It is in these cases that, as a result of the chronic inflammation and thickening, the capacity of the bladder may be much diminished permanently, so that frequency persists as a result of its small containing power.

Treatment. This should consist primarily in removing any cause that can be discovered. If this is done, large quantities of fluid are given, and urinary antiseptics are employed, the cystitis probably will clear up gradually, especially if the patient is up and about.

In chronic and persistent cases (usually seen in women) and especially those due to B. coli, marked improvement sometimes follows if the patient is placed on sulphanilamides or upon a *ketogenetic diet*; the ketones in the urine rapidly getting rid of the organisms. The principle of the diet is to reduce the carbohydrate intake as much as possible and to increase the fats. There are several ways of doing this, and as the amounts required of different substances vary greatly from one patient to another, it is impossible to give a fixed scheme. A rough plan of such a diet is as follows for the twenty-four hours :—

Fluid. Only 2 pints and only saccharine for sweetening.

Fats. About 250 grammes, in the form of 14 ounces of cream, 3 ounces of butter and the rest in bacon and meat fat. These can be taken with fruit, icecream, tea, coffee, gluten rolls, etc.

Carbohydrates. About 15 grammes, as far as possible in the form of vegetables and fruits.

Proteins. About 80 grammes as meat, fish, eggs and cheese.

Marked improvement in many of these cases is effected by means of mandelic acid, which is a most effective urinary antiseptic. This may be given in several different ways, one important point being that certain mandelate salts are most unpalatable and indigestible.

One method is to prescribe it as follows :—

℞

Mandelic Acid	gms. iii
Sod. Bicarb.	gms. 1·6
Syr. Limon	ʒi
Aq.	ad ℥i t.d.s.

and this must be preceded by

℞

Ammon. Chlorid.	gm. i
Aq. Chloroformi	ad ℥i t.d.s.c.

The intake of fluids should be restricted to two pints a day. An alternative to the first prescription is as follows :—

℞

Sodium Mandelate	grs. l
Syr. Orange	ʒi
Aq.	ad ℥i

to be taken in water four times a day.

A more recent and much more palatable method of taking *the remedy is in some form of the ammonium salt.*

℞

Mandelix or Neoket	ʒii

Four times a day after food.

The common cause of failure is some obstruction to the urinary outflow, and where the treatment is proving unsuccessful such should be looked for and treated. Renal inefficiency with a high blood urea is an absolute contra-indication to the administration of mandelic acid in any form or to the use of a ketogenic diet.

Irrigation of the bladder is always a valuable method of treatment whether the primary cause has been removed or not. A bladder wash is performed by passing a soft rubber catheter into the bladder; the irrigating fluid is then allowed to flow up the catheter either by means of a syringe or better under gravity by a tube and funnel about 3 feet long. The funnel is raised, and enough fluid is run into the bladder to distend it gently. The funnel is then turned upside down and lowered over the edge of the bed over a bucket or receptacle so that the fluid will flow out again as a result of syphonage. This should be repeated over and over again until the washings appear quite clean and clear. Many different solutions may be used, such as potassium permanganate 1 in 5,000, boracic acid 20 grains to the ounce, perchloride of mercury 1 in 5,000, oxycyanate of mercury 1 in 5,000, silver nitrate solution 1 in 1,000. No pain should be caused, and different solutions may be used on different days, while the irrigation should be performed once or twice a day. The most perfect asepsis must be practised.

An alternative method of doing this which is very easy to perform while the bladder is being drained suprapubically, but which can be done also when the bladder is unopened, is to use a sterile Higginson's syringe, the nozzle of which fits closely into the urethra. By means of this, from about 10 to 20 ozs. of fluid are forced up into the bladder, the meatus of the urethra being held firmly round the nozzle of the syringe. If the bladder is opened, the fluid will flow out, while if unopened the patient is instructed to pass it in a minute or two. The process is repeated over and over again.

Instillation into the bladder is sometimes valuable in chronic cystitis. The bladder is emptied, and a small quantity of an antiseptic solution is injected drop by drop into its neck by means of a soft rubber catheter and syringe. Potassium permanganate, 1 in 5,000, and nitrate of silver of the usual strength (1 in 1,000) may be used.

In addition to these methods, the patient's general life and habits must be controlled carefully. No alcohol should be allowed except in the form of gin, and he should take large quantities of milk, barley water or Contrexéville. Urinary antiseptics should be given and every step possible taken to alter the reaction of the urine from alkaline to acid or vice versâ. The most valuable of these urinary antiseptics will be found to be oil of copaiba, sandalwood oil, sulphonilamide, urotropin, salol, boric acid, benzoic acid, buchu and uva-ursi; cubebs also is useful.

In very chronic cases which will not react to any of the above forms of treatment vaccines will be useful, especially if the infection is due to B. coli, but even then many cases will prove resistant. A few cases will remain where the condition persists, and gravely affects the patient's health. In these cases drainage of the bladder will be necessary; it may be performed either by the perineal or suprapubic route (see pp. 886, 887).

Useful prescriptions, by means of which urinary antiseptics may be administered, are :—

℞

Urotropin		grs. x
Ac. Sod. phosph.		grs. xv
Tr. Hyoscyami		♏x
Sp. Chloroformi		♏xv
Inf. Buchu	ad	℥j, t.d.s.p.c.

℞

Pot. Citrat.		grs. xx–ʒj
Tr. Hyoscyami		♏xx
Emuls. Chloroformi		♏x
Inf. Buchu	ad	℥j, t.d.s.p.c.

℞

Ac. Boracic.		grs. v
Tr. Hyoscyami		♏xxv
Sp. Chloroformi		♏xv
Inf. Buchu	ad	℥j, t.d.s.p.c.

℞

Urotropin		grs. x
Sod. Benzoat.		grs. x
Sp. Chloroformi		♏x
Inf. Buchu	ad	℥j, t.d.s p.c.

℞

Salol		grs. v
Ac. Boracic.		grs. x
Sp. Chloroformi		♏x
Inf. Buchu	ad	℥j, t.d.s.p.c.

Certain special forms of cystitis are worthy of mention.

(A) **Bacilluria.** This has already been described on p. 854. Large quantities of bacilli are present in the urine without the bladder wall being affected, the organisms usually being either B. coli or B. typhosus. Slight irritability of the bladder may be present, and occasionally in children there will be incontinence, but usually the patient complains of nothing except that the urine is cloudy, opalescent and has a nasty fishy smell. The cloudiness does not disappear if acid is added, for the urine is nearly always acid itself.

On examination the urine is full of bacilli and mucus, but there is no pus. The condition may terminate spontaneously or ultimately may give rise to infection of the kidneys or bladder. Special attention should be given to the general health and the digestive tract, while urinary antiseptics usually will soon cure the condition.

(B) **Gonorrhœal Cystitis.** This is rare, but is usually the result of the extension of a posterior urethritis, the neck and the base of the bladder being chiefly affected. It gives rise to most intense pain and is described in Ch. VI., Vol. I.

(C) **Typhoid and Pneumococcal Cystitis.** These are both acute forms of cystitis which appear in connection with either of the above infections ; they both usually clear up rapidly under general treatment.

(D) In connection with diseases and injuries of the spinal cord a symptomless cystitis, which combines the features of both acute and chronic cystitis, is frequently seen, the urine being very foul and ammoniacal and full of pus. There is a grave likelihood of this giving rise to double surgical kidneys and to stone formation. Incontinence is often present also as a result of the spinal lesion.

Treatment on the above lines should be given, while in incontinence the penis is surrounded by sterile gauze and kept inside a frequently changed urine bottle. In many cases the greatest safety and comfort will be obtained by opening the bladder and installing suction drainage. This should be done at once if signs of ascending pyelonephritis are present.

Simple Ulcer of the Bladder. This is a rare condition, seen in young men, and consisting in a single, shallow ulcer, usually at the trigone or neck of the bladder, of unknown origin. It can be seen with the cystoscope and is usually covered with phosphates, while it gives rise to frequency, urgency and irritability of the bladder with hæmaturia. The bladder may be washed out with lactic acid (3 per cent.), or it may be opened and the ulcer scraped or cauterised.

TUBERCULOSIS OF THE BLADDER

Tuberculosis of the bladder is practically always secondary to tuberculosis elsewhere in the genito-urinary tract, especially in the kidney, prostate or testicle. It is possible that a primary tuberculous disease of the bladder occurs, but it is very rare. It will be seen thus that it usually forms part of a generalised genito-urinary tuberculosis (see p. 842). Moreover, it frequently happens that tubercle bacilli pass down in the urine from the kidney to the bladder for years without the bladder becoming infected, and it is probable that in all cases the infection reaches the bladder mucous membrane via its lymphatics and not from its surface. Descending infection does undoubtedly occur from the kidney, but this is by means of the peri-ureteral lymphatics, so that the disease is seen to commence in the bladder close to the orifice of the ureter on that side.

Rarely an ascending type of infection also occurs where the disease involves the bladder by spreading from the testicle, epididymis, prostate or vesiculæ seminales, either by the lymphatics or by direct continuity.

The disease probably commences as a deposit of submucous tubercles which approach the surface, giving rise to red patches on the mucous membrane, which increase in size, coalesce and ulcerate as the result of caseation underneath. Multiple, superficial, small ulcers with ragged edges are soon formed ; these are seen especially round one or other ureter, or on or near the trigone. In the later stages diffuse polypoid masses of granulation tissue are formed. Very soon a septic infection becomes superadded, so that a generalised subacute pyogenic cystitis supervenes, and the urine, acid at first, becomes alkaline. As a result of this chronic cystitis, the changes described on p. 864 may be seen. A small contracted bladder with very thick sclerosed walls and only holding an ounce or two is common, especially in women.

Clinical Features. The disease is most common in young adult men, who have already got tuberculosis elsewhere in the genito-urinary tract. Being most frequently secondary to tuberculous kidney, which, as described on p. 843, often gives rise very largely to bladder symptoms, the symptoms due to the cystitis may at first be difficult to distinguish. Intense irritation of the bladder with frequency and urgency, hæmaturia and burning pain in the penis on micturition are common and intractable, the bladder tenesmus being almost continuous by day and especially by night, for rest in bed at night often makes the symptoms worse. The urine is usually full of pus and débris, while tubercle bacilli are easily found. It is increased in amount and contains flaky shreds and débris. It is acid in the early stages and alkaline in the later ones.

Cystoscopy will be necessary. In the early stages this will demonstrate the change in the ureteric mouths and the early congestion and ulceration, while the state of each kidney can be investigated. Miliary tubercles are rarely seen. In the later stages the bladder is so contracted and septic that little will be seen. Important evidence may be obtained by discovering signs of tuberculosis in the kidney, prostate, vesicles or testicle. The early cases are favourable, provided the primary cause is removed; in the later stages the prognosis is very unfavourable.

Treatment. This consists, first of all, in removing the primary seat of the disease, such as the kidney or testicle, if possible; and in mild cases this will cause the disease to clear up, under general anti-tuberculous treatment. Irrigation of the bladder is harmful, while the administration of urinary antiseptics rarely does any good whatever. Tuberculin is often beneficial in this condition, as in all forms of genito-urinary tuberculosis.

If the condition does not improve under general treatment the outlook is bad, though benefit sometimes follows the instillation of mercurochrome or of small amounts of a 10 per cent. solution of iodoform and glycerine.

In advanced cases the patient's condition is miserable in the extreme with incessant pain, bladder spasm and passage of small quantities of burning urine. In some of these cases the bladder has been opened suprapubically and the diseased mucous membrane removed with scissors or the cautery. This, however, is never advisable, as a tuberculous fistula is likely to follow. In other severe cases the bladder may be put out of action and some of the discomfort relieved by bringing the ureters or ureter, if one kidney already has been removed, out on to the skin of the loin; the patient will then have to wear a receptacle to collect the urine. Death usually occurs from exhaustion, renal failure, lardaceous disease or generalised tuberculosis.

STONE IN THE BLADDER

Certain details with regard to urinary calculi in general have been described on p. 834. Bladder stones have exactly the same characteristics and constituents as do other urinary stones (see p. 834). They are thus composed of uric acid, urates of ammonium and sodium, or calcium oxalate, these all forming in an acid urine. Cystine and xanthin stones occasionally form in the bladder, while phosphatic stones are particularly common and form in an alkaline urine. Pure phosphatic stones are rare, but nearly every bladder stone will be found to have a soft friable deposit of phosphates over its outer surface as a result of chronic infection with alkalinity of the urine.

There is no doubt that a large number of bladder calculi originally have formed in the kidney and passed down the ureter, when they lie in the bladder and increase in size, phosphates being deposited upon them comparatively rapidly. A certain number of calculi are formed in the bladder itself; this is the case when a calculus is formed upon a foreign body, such as a broken catheter, etc., previously present in the bladder, while in other instances phosphatic calculi are formed spontaneously in saccules and diverticula of the bladder. With these exceptions the causes of bladder calculus are therefore the same as those of urinary calculus in general.

Vesical calculi tend to be rounded and smooth; they are much less irregular in shape than renal calculi, and branched and irregular forms rarely occur. If multiple calculi are present they are small, and have facetted faces, hundreds having been recorded in one bladder. Single stones, on the other hand, may be very large and heavy. In some instances a stone will form more or less of a cast of that portion of the bladder in which it lies; thus grooves are seen on calculi corresponding in position to the ureteric bar, and stones with an hourglass constriction occur, showing that part of the stone has laid in the bladder and part in a diverticulum, in the commencement of the urethra or the lower end of the ureter. When a stone is long and thin it is probably formed round an elongated foreign body.

Vesical calculi have a great tendency to be laminated on section; they usually have a nucleus which may be formed by blood clot, bacteria, inspissated mucus, a foreign body or a calculus which has descended from the kidney. Outside this are superimposed many layers of urates, uric acid or calcium oxalate, the layers sometimes alternating between the different substances and consisting of minute crystals held together by inspissated mucus. The outer layer of the stone, of variable thickness, nearly always consists of soft white phosphates. Bladder stones may reach a great size, so that the bladder wall is distended and stretched around them, while projections from the stone sometimes pass down the urethra and cause incontinence.

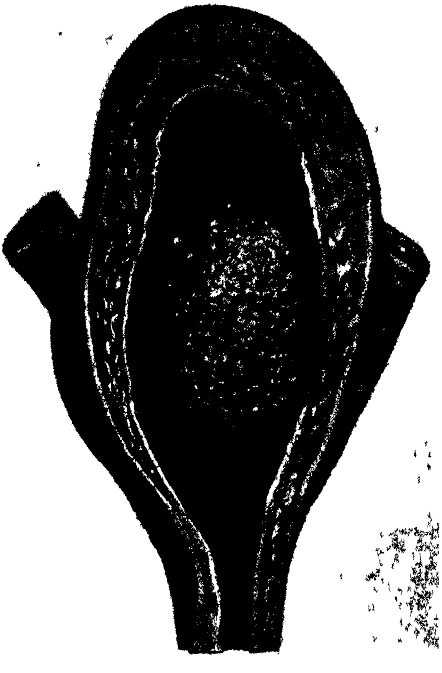


FIG. 290. A large stone lying in a much hypertrophied bladder.

Most stones lie free on the bottom of the bladder and are able to move about unless they are very large, when they may be fixed by the bladder contracting upon them or by being imbedded in granulations.

An *encysted calculus*, however, is sometimes seen which lies in a pocket or pouch in the bladder wall; thus it may lie in a saccule or diverticulum, in the prostate, in a large post-prostatic pouch, or in the mouth of the ureter or urethra, while such a stone will grow in size in situ. Such an encysted calculus is by no means free from danger, as it may ulcerate through the bladder wall and give rise to extravasation of urine.

The results of a vesical calculus are various; infection and cystitis are certain to occur sooner or later; trabeculation of the bladder with the formation of pouches may be an effect, as well as a cause. Ulceration of the bladder is seen, and in many instances pyelitis and pyelonephritis ultimately set in.

Clinical Features. These stones are much more common in men than in women, partly because of the latter having a short wide urethra down which calculi can pass, and also because they do not so often suffer from chronic cystitis. Bladder stone is common in children, especially boys of under ten years old, and it is more common in hospital patients than in private patients. In women, a calculus is frequently due to the introduction of a foreign body. In middle life vesical calculus is uncommon, but it becomes comparatively frequent again in men over fifty-five.

Bladder calculus exhibits a very well-marked distribution in different parts of the world, much more so than does renal calculus; thus it is common in the eastern counties, in tropical countries, and the East, and especially in India, Egypt, Arabia and the Balkan peninsula. This is probably due partly to the nature of the drinking water, and partly to the concentrated character of the urine owing to excessive perspiration in torrid climates.

The signs and symptoms will depend largely upon the shape and size of the stone, the sensitiveness or tolerance of the bladder mucous membrane and the degree of urinary infection present. Small stones are more likely to cause severe symptoms than large ones, rough ones than smooth ones, while children and young adults get more severe symptoms from their sensitive parts than do old men, who often tolerate large, rough stones. Spiky stones such as those formed of calcium oxalate give rise to more severe symptoms than do smooth ones, such as uric acid and urates.

In many cases there is a previous history of the patient passing sand or gravel or of renal colic, pointing to the passage of a stone down from the kidney, and it is possible that small stones may lie in the bladder for a long time before commencing to give trouble.

The chief symptoms of a vesical calculus are pain, hæmorrhage and frequency, all of which are increased in severity by exercise, jolting or bumping, while they are much better at night when the patient is in bed. Patients frequently sleep and lie on their face to lift the stone off the sensitive trigone.

The *pain* is chiefly in the perineum or at the neck of the bladder, and occurs especially during and at the end of micturition, when it may be noticed specially at the tip of the penis. At times it radiates down the back and thighs, while small boys are sometimes noticed suddenly to catch hold of the tip of their penis or scream when passing water.

The hæmaturia also follows movements, and is of the bladder type, not usually severe unless the stone is a sharp and spiky one. It always stops when the patient is in bed. Occasionally a few bright drops of blood are passed at the end of micturition.

The frequency is not marked as a rule unless cystitis is present, and usually occurs after exercise. Another symptom of which some patients complain is that while passing urine the stream is suddenly stopped with more or less of a jerk, micturition again being possible after a slight pause or change in position. When this occurs it is characteristic either of a stone, a bladder growth or a backward projecting lobe of the prostate.

Occasionally acute retention occurs from such a stone becoming impacted in some portion of the urethra, most commonly in the penile part (see p. 897).

Other signs and symptoms may be present; thus sooner or later it is almost certain that cystitis will supervene; the urine becomes alkaline and the symptoms more marked, frequency and pain often persisting by night as well as by day, while occasionally urgency and frequency are intense. Rectal tenesmus with piles or prolapse and hernial formation are sometimes seen from the straining, while sooner or later ascending infection of the kidneys with pyelonephritis will supervene.

In children, especially small ones, the symptoms are naturally modified, and may consist in their wetting their clothes and their bed and pulling at their penis and prepuce, which latter may become elongated as a result, while priapism is seen not infrequently.

On examination the urine may be found normal, but often a slight amount of albumen, mucus, pus or blood will be detectable. In children a vesical calculus occasionally can be felt on bi-manual examination.

An X-ray examination is essential, and nearly every stone will cast a detectable shadow, which is usually just above the pubic rami. It must not be forgotten that such conditions as fæcoliths, osteomata or calcified fibroids may give rise to rather similar appearances. Both kidneys and ureters must be X-rayed *always* as well as the bladder.

Sounding for Stone. Naturally this method has been replaced almost entirely by cystoscopy. It is, however, occasionally of value in small children when a child's cystoscope is unobtainable. The bladder is filled, the patient placed in the Trendelenburg position, and the sound passed. By manipulating it backwards and forwards and round and round, the stone is almost certain to be struck and felt. There is more art in this than there appears to be, though it may at present be regarded almost as a lost art; for the older surgeons often could tell the size, shape and composition of a stone with the sound.

The final and absolutely certain diagnosis of a vesical calculus is, of course, made by means of cystoscopy. In most cases this settles the matter immediately, as it will show the shape, size, position, number and colour of the stones, while other accompanying conditions may be demonstrated, such as diverticula or prostatic enlargement. It must be remembered that in many cases stones are discovered unexpectedly at operations, as complications of such other conditions as stricture, enlarged prostate, or growths of the bladder.

Treatment. The only treatment for a stone in the bladder consists in its removal by operation.

In many cases it may be advisable to keep the patient in bed for a few days before the operation in order to improve his general condition and renal efficiency. This is especially so in those cases where cystitis and pyelonephritis are present.

Two types of operation are practised, that of " cutting for the stone " (lithotomy and crushing the stone (lithotrity).

With regard to the choice of these two operations there is much difference of opinion. *Lithotrity* is in many ways the operation of choice, though it is not possible in all cases. There is no doubt that the largest and hardest stones may be crushed if the necessary skill and instruments are obtainable. At the same time it is a considerably more difficult operation in many cases than is lithotomy, and takes a great deal longer. Though no incision is made, and very little bleeding occurs in lithotrity, there are certain risks peculiar to the operation. Thus cystitis is particularly likely to follow, as there is no drainage of the bladder. Damage to the bladder wall, or even perforation, may occur, while ascending pyelonephritis with uræmia is sometimes set up.

There are certain conditions in which lithotrity is definitely contra-indicated.

(*a*) If a stone is more than 1½ inches in diameter, it may be difficult or impossible to grasp, while oxalate stones are difficult to crush. In the case of an encysted stone the operation would be highly dangerous, as the bladder wall probably would be damaged. The same applies in the case of small contracted bladders or large stones.

(*b*) If there is a stricture which prevents the lithotrite being passed; the same applies to an enlarged prostate, for here the stone may lie hidden in a post-prostatic pouch. A history of rigors following catheterisation also renders it unwise.

(*c*) The presence of some other condition which is to be dealt with by operation at the same time, such as an enlarged prostate or a bladder growth.

(*d*) The presence of marked cystitis or diverticula in the bladder wall.

(*e*) In male children under eight, because of the size of the urethra.

Lithotrity (Litholapaxy). At one time the stone was crushed and recrushed at intervals, and the patient allowed to pass the fragments in between. The introduction of Bigelow's evacuator, however, has altered all this, and the whole operation can be performed in one sitting, the fragments being evacuated there and then. The skin is sterilised, the patient anæsthetised and placed in the Trendelenburg position. The bladder is washed out with an antiseptic solution, 10 ozs. of fluid are left in it, and the lithotrite is passed with its blades closed. It corresponds roughly in size to a 16/20 English sound. The blades are then opened with the sliding mechanism, and on passing them to the base of the bladder, the stone will fall between them and be gripped by sliding the blades together. It is then carried to the centre of the bladder, and the screw thread put into gear, the lithotrite is screwed up, and the stone crushed. This naturally puts a considerable strain on the lithotrite. Each of the subsequent fragments is again caught and crushed again until they are thought to be small enough to pass through the tube of the evacuator. When this is satisfactorily performed, the lithotrite is withdrawn, the evacuator introduced and the stone sucked out by alternately compressing and releasing the rubber bottle. To

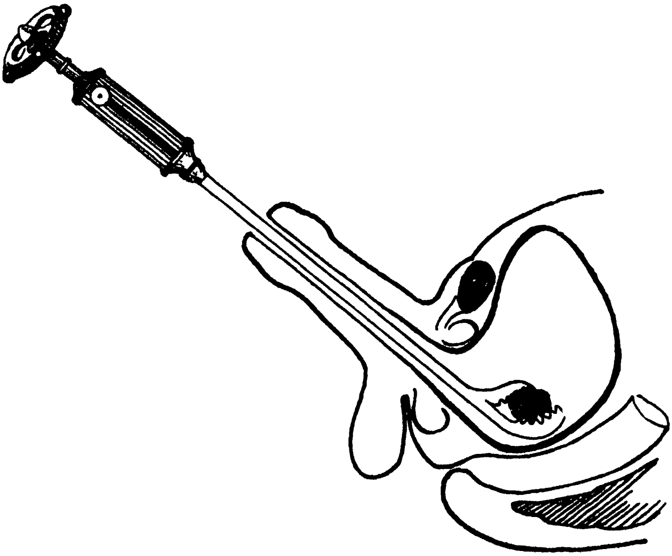


FIG. 291. The lithotrite grasping a vesical calculus.

make certain that all fragments have been evacuated the cystoscope should be passed and the bladder investigated, when it may be seen that further crushing is necessary. In children, naturally, much smaller instruments must be used.

Complications which may follow this procedure are (*a*) the lithotrite may break, or become clogged or immovable. In this case the bladder must be opened; (*b*) severe cystitis and pyelonephritis may follow; (*c*) the bladder wall may be injured.

After-treatment. Only slight bleeding should occur, but if by any chance it is severe, the bladder may become full of clot. Distension of the bladder with blood clot gives rise to severe pain and marked shock. This will necessitate either washing it out with a large-eyed catheter, or sometimes a suprapubic opening with drainage. After the operation the patient should be kept warm in bed for two or three days and given a light diet with plenty of bland warm fluids. Urinary antiseptics should be administered.

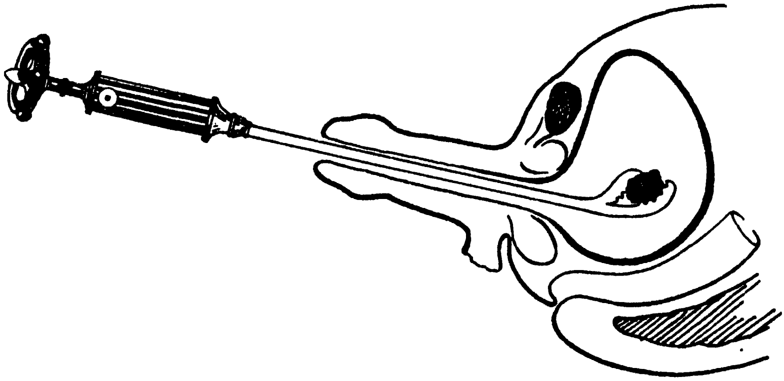


FIG. 292. Lithotrite in position with the stone grasped and lifted off the floor of the bladder (to be certain that no mucosa is picked up).

Occasionally, on account of a stricture, etc., the lithotrite cannot be passed. *Keith's perineal litholapaxy* may then be performed. The membranous urethra is opened upon a staff, the lithotrite introduced into the bladder through this wound, and the stone crushed. The evacuator is then used through the perineal wound.

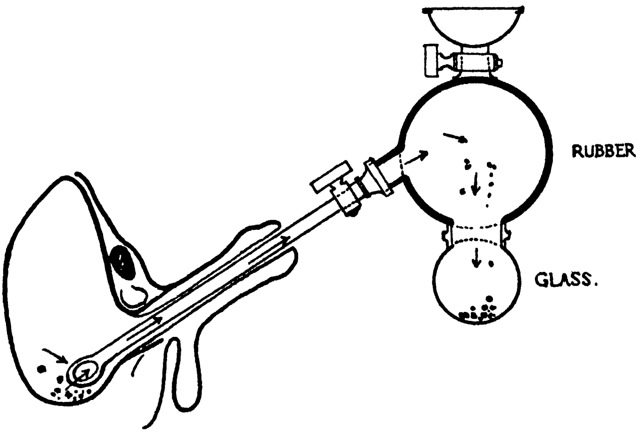


FIG. 293. Removing crushed fragments of a vesical calculus with the evacuator.

Other enthusiasts have opened the membranous urethra and incised the prostate so that straight, strong crushing forceps can be introduced into the bladder this way and the stone crushed.

We are strongly of the opinion that if litholapaxy is likely to prove anything but the simplest of procedures, a lithotomy should be performed.

Lithotomy. If for any of the reasons already described litholapaxy is considered unwise, the stone can be removed easily by lithotomy. Three types of lithotomy have been practised:

(*a*) *Lateral perineal lithotomy*, where the stone is removed through the lateral portion of the perineum by incising the prostate. This operation is no longer performed, except upon African natives, who will insist on going out of hospital on the next day.

(*b*) *Median perineal lithotomy.* Here the bladder is opened as described on p. 887 under perineal cystostomy, the stone is removed and the bladder drained if thought necessary. This operation is practically never performed nowadays. It is impossible except in the case of small stones, though it is occasionally advisable if a stone is impacted in the neck of the bladder, or intense cystitis is present.

(*c*) *Suprapubic lithotomy.* This is the form of operation employed in practically all cases. The bladder is opened above the pubes, as described on p. 886, the stone is felt and removed with forceps. If the urine is uninfected, the bladder may then be sutured with a continuous catgut stitch, and the wound closed without drainage, but if cystitis and infection of the urine are present, the bladder must be drained for from five to seven days (see p. 886). By this operation any other condition, such as enlarged prostate or growth of the bladder, can be dealt with at the same time. (For details of after-treatment, see p. 886.)

Vesical Calculus in Females and Children. The treatment here differs very little from that described above. In the female small calculi ½ inch in diameter may be withdrawn by stretching the urethra slightly, while otherwise litholapaxy or lithotomy may be employed. An operation has been described for removing a vesical calculus through the anterior vaginal wall. This is most undesirable, as a vesico-vaginal fistula is likely to form.

In children lithotomy is to be preferred to litholapaxy ; the former is even easier than in adults, as the bladder lies high, while the latter is considerably more difficult.

Recurrence of Vesical Calculi. This is occasionally seen, especially in elderly people. It is nearly always due to the persistence of chronic cystitis, possibly due to urethral obstruction, which gives rise to the formation of a phosphatic stone. In other cases it may be due to further stones passing down from the kidney or to small stones or fragments being left behind at the first operation. After removal of a stone, steps must be taken, therefore, by controlling the patient's life, exercise and diet, and providing him with plenty of fluids to hasten the clearing up of cystitis and to render the further formation of stones unlikely (see p. 866).

GROWTHS OF THE BLADDER

Growths arising in the bladder wall are common in both simple and malignant forms. The commonest growth of all, the papilloma, is one which appears to be on the border line of malignancy.

Certain growths occurring at the apex of the bladder and just above it really arise in the urachus, and are described on p. 858.

(A) *Simple Growths. Myoma, Myxoma, Angioma and Fibroma* are occasionally seen. They give rise to vague symptoms consisting of intermittent dysuria, but on passing the cystoscope they will be detected at once. The last appears as a round, shining, egg-like structure with big veins running across it. They must be removed by operation. A rare bladder tumour is a pedunculated rhabdomyoma.

Papilloma of the Bladder. This is a common tumour, sometimes known as a villous bladder tumour; though apparently innocent, it is frequently on the borderline of malignancy and often after some years becomes frankly malignant. It appears as a soft pedunculated, sprouting, papilliferous white mass with thread-like processes floating in the urine, and grows from the mucous membrane of the bladder, usually from the trigone or near one of the ureteric openings. It may drag upon and obstruct the ureter and so cause a hydronephrosis. Often there is one large tumour with many little ones growing round it, while sometimes the whole bladder is covered with small seedling growths. Occasionally sessile and firmer types are seen. In Germany a remarkable frequency of bladder papilloma has been noted among aniline dye workers. It is common in men between twenty-five and forty, and rare in women. On microscopic examination each tuft or frill appears to be a typical papilloma with a fine central connective tissue core containing blood vessels, which is covered with a thin layer of transitional epithelium corresponding to that of the bladder (Vol. I., Fig. 75).

Clinical Features. The one characteristic symptom is painless hæmaturia, the blood being bright red and mixed with the urine, which is often a port wine colour. This hæmorrhage is intermittent, each attack lasting a few days or a few weeks and then disappearing for a short or a long period; the bleeding starts or stops without any obvious cause, and tends to become more pronounced and more continuous the longer the growth goes on, until finally the patient becomes profoundly anæmic. Though the blood is usually mixed with the urine, in some cases it appears to be more marked at the end of micturition, and a few bright drops may appear at the end. After some time irritability of the bladder will set in, which may be due to the irritation of a large growth, but is more commonly the result of the onset of cystitis with an alkaline urine. In this case, as well as containing blood, the urine will contain pus and mucus, while in addition occasionally small fragments of the growth may appear in the urine. When a pedunculated growth is

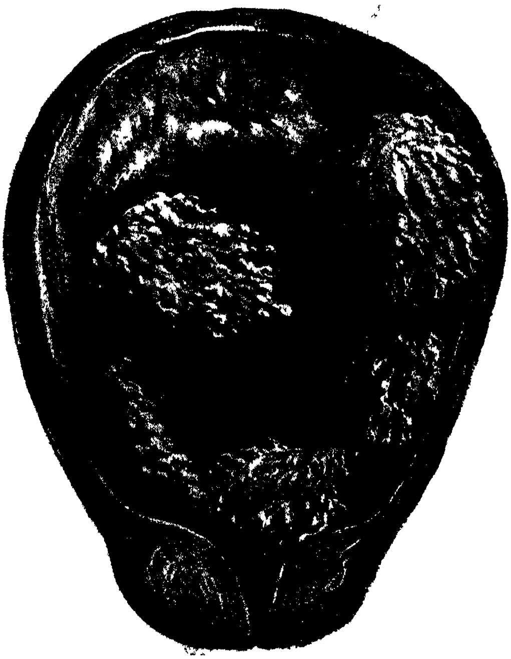


FIG. 294. Multiple villous papillomata of the bladder.

present near the urethral opening, a portion of it sometimes may pass into the urethra during micturition and block it suddenly, so that the stream stops with a sudden jerk and sharp pain is felt in the penis. In other instances, one or both of the ureteric openings may be blocked, so that a hydronephrosis is caused. Beyond the fact that the patient may become profoundly anæmic, the general health is often unaffected for years, while the growth may persist for a very long period without giving further trouble. The longer it lasts the more likely it is to become malignant.

The diagnosis is naturally made with the cystoscope. This will demonstrate the condition at once, though there may be some difficulty in seeing it, owing either to excessive blood in the urine or the bladder being absolutely full of villous growth. Cystoscopy is absolutely essential in every case of symptomless hæmaturia.

It may not be easy from the cystoscopic appearances to settle whether any growth seen is simple or malignant. Simple papillomata are usually white, frilled, papilliferous and pedunculated, with processes and tendrils floating about in the urine, while malignant growths are not papilliferous (*i.e.*, they are bald), and necrosis of the growth with ulceration, encrustation with phosphates and œdema of the bladder wall around the tumour all suggest malignancy. In addition to this, if any induration or swelling can be felt, either from the abdomen, the rectum or the vagina, the growth is certainly malignant. Malignant growths, in particular, are liable to give rise to a most intractable cystitis.

Treatment. This will depend on how large the tumour is.

(*a*) If it is the size of a marble or smaller it can be destroyed completely by means of defulgurisation through the cystoscope. To do this, an ordinary catheterising cystoscope is used, and instead of a ureteric catheter a special electrode is passed into the bladder, the electrode being insulated the whole way up except at its tip. The second electrode is attached to the patient's thigh with a metal plate moistened with saline, and a high frequency high potential current is employed, the electrode being brought into contact with the growth under cystoscopic observation. Various parts of the growth are touched by the electrode, and when the current is turned on the growth turns white, shrinks, and is burnt up. Two or three sittings may be required; no anæsthetic is necessary, provided only the tumour is touched, and the patient need not be confined to bed.

(*b*) In larger growths or multiple ones a suprapubic cystotomy must be performed and the growth excised by open operation.

The patient is placed in the Trendelenburg position, the bladder is opened, and a special retractor introduced which carries a small sterilised electric light down into the depths of the bladder. The growth is removed with a small area of mucous membrane around its pedicle, while if it is thought that the growth is malignant a portion of the whole thickness of the bladder wall around it is excised. Great care must be taken of the ureters and their mouths. The bladder wall is then repaired and all bleeding stopped by continuous catgut sutures. If all hæmorrhage is stopped and the bladder appears quite dry, the suprapubic incision in the bladder may be closed without drainage with a continuous catgut stitch. In this case a small rubber catheter is tied into the urethra for about five days, and when it is taken out the patient must be made to pass water every two hours for some further days to prevent the bladder ever becoming distended. If, however, oozing is still occurring into the bladder or cystitis is present, a tube must be introduced to drain it suprapubically or else it may become distended with clot. In all cases the urine should be kept acid afterwards with acid sodium phosphate and urotropin be administered together with plenty of fluids.

Care must be taken during these operations not to allow small portions of the growth to become detached and remain in contact with other parts of the bladder or they may become implanted and grow there. The after-results of defulgurisation in suitable cases and of complete excision are most satisfactory. The patient should, however, be kept under observation and examined with the cystoscope every six months to make sure there is no recurrence. Occasionally a recurrence is seen in the scar in the abdominal wall; several cases have been reported recently where a papilloma has grown in the scar of suprapubic wound, two or three years subsequent to the original removal of the bladder growth; such tumours are very vascular, often malignant, and must be excised.

(*c*) Radium either planted around or introduced into the bladder and left for eight days results in most cases in complete disappearance of papillomata, and is to be advocated in all cases of multiple growths; it is as yet too early to say whether recurrence will occur ultimately.

(B) *Malignant Growths.* These are common and may be either carcinoma or sarcoma.

Carcinoma of the Bladder. Primary carcinoma of the bladder is usually of an atypical squamous-celled type arising in the transitional epithelium of the bladder wall, while a glandular columnar-celled carcinoma is occasionally seen. In some cases the growth follows a malignant change in a papilloma. Secondary carcinoma of the bladder also occurs when this organ is involved in growths which have originated in the rectum, prostate, or other tissues. Carcinoma of the bladder is most usually seen at the back of the organ just above the trigone and near the ureteric openings. Most commonly it gives rise to an ulcerating, infiltrating growth which eats deeply into the bladder wall and becomes indurated and fixed; the ulcerated surface is often covered with phosphatic deposit. Occasionally a sprouting, papilliferous form is seen which exhibits a certain amount of sloughing (unlike a simple papilloma), causes less infiltration of the bladder wall and is a more favourable type. An intractable, subacute cystitis is nearly always set up early, and usually the patient does not survive long, owing to spread of infection to the kidneys combined with obstruction of the ureters. Distant metastases are not, therefore, often seen. The growth seldom occurs under the age of forty-five.

Clinical Features. This condition is much more common in men, and, as in simple growths, the main symptom is hæmaturia. This, however, tends to be much less profuse, but more continuous than in papillomata, and once hæmorrhage has started it does not often cease for long, while it persists in spite of treatment and rest in bed. At first there is little pain or irritability, but very soon a moderately acute cystitis sets in, which gives rise to frequency, urgency and pyuria. In some cases these symptoms are the first noticed, and their onset in a patient of over fifty should always raise a suspicion of carcinoma of the bladder. An indurated swelling due to the growth can be felt in the later stages either from the abdomen, the vagina, or the rectum, and is characteristic.

In the late stages intense frequency, dysuria and pain set in, agonising bladder spasms occurring at frequent intervals. The urine is foul, full of pus and blood and fragments of growth may be present, while occasionally, when the growth is near the urethral opening, sudden obstruction to micturition occurs. Hydronephrosis is also liable to be caused. The pain radiates from the bladder region down the thighs and buttock and the patient is sleepless and never easy.

Cachexia due to septic absorption and exhaustion from sleeplessness due to the frequent bladder spasms and irritation soon become marked, while occasionally a rectovesical fistula or perforation of the bladder with extravasation of urine complicate the condition. In most instances the patient succumbs from septic pyelonephritis, combined with anæmia and exhaustion.

The diagnosis is settled by the cystoscope as the growth can then be seen, while the question of its operability will be settled by noting its size, situation and mobility. In early cystoscopy lies the only hope of surgical treatment obtaining a cure. The different cystoscopic appearances of simple and malignant growths are described on pp. 878, 879.

Sarcoma of the Bladder. This is rare and usually occurs in children, where it may give rise to multiple, polypoid, grape-like growths. It grows rapidly, and gives rise to a large rounded tumour infiltrating the bladder wall and tissues round, spreading to the lymphatic glands, but not as a rule ulcerating early. The symptoms are again hæmaturia, followed by irritability of the bladder and frequency, while sudden retention may occur. The growth often can be felt as a fixed elastic tumour either from the abdomen or bimanually. It is not likely to be removable.

Treatment. In the treatment of malignant disease of the bladder the only hope lies in early and extensive operation. The whole thickness of the bladder wall must be removed for a considerable distance round the base of the tumour, and if this necessitates opening the peritoneum there should be no hesitation whatever in doing so. If the tumour is near the trigone or ureteric mouths a portion of the ureter may be removed with the growth and the rest of the ureter must be transplanted into another opening in the bladder. At all costs the urethral opening with its sphincter must be preserved. After this excision the bladder wall is repaired by means of continuous catgut sutures. The bladder must be drained suprapubically for at least ten days.

Complete cystectomy has occasionally been performed, though a growth which requires this might be regarded as inoperable by a wise surgeon. Enthusiasts have even removed the prostate and seminal vesicles with the bladder. If this is to be done a preliminary transplantation of the ureters will be necessary. They may be implanted into the rectum or colon or brought out in the loin ; the actual removal of the bladder is not necessarily a very severe procedure, but the patient's condition after it is miserable.

Conditions which render excision impracticable are : (1) Gross pyelonephritis, (2) secondary deposits, (3) fixity to and infiltration of the structures around the bladder.

In inoperable cases the application of radium so as to produce a cross-fire action may be tried. This is introduced by means of a suprapubic opening, either into or around the growth, but we have never seen any permanent good come of it.

In other advanced cases the patient's suffering must be relieved as much as possible. Bladder cramps and spasms can be relieved by large doses of hyoscyamus or chloroform inhalation, while a permanent suprapubic drainage of the bladder or drainage of the kidneys into the loin may also help. Morphia and bladder washes also should be made use of. Occasionally transplantation of the ureters into the colon to prevent any urine reaching the bladder, or a presacral neurectomy has been performed to relieve pain and frequency.

DIVERTICULUM OF THE BLADDER

This is a rare condition where an offshoot or diverticulum of the bladder is formed, nearly always as the result of some obstruction to micturition, such as an enlarged prostate or a stricture. The process probably starts as a herniation of the mucous membrane between the muscular bundles of a trabeculated bladder. If this is so several small pouches are likely to be formed. Technically a *pouch* has a wide opening into the bladder, and a *diverticulum* a narrow mouth. Both conditions are very rare in women.

In other cases, however, one very large pouch is formed, which may be as big as or even bigger than the main portion of the bladder itself, and very often no sign of urinary obstruction is then present. The probability is that a single diverticulum is congenital. The wall contains no muscle, so that the pouch cannot be emptied, while it usually projects through a narrow opening at the lower part of the back wall of the bladder. It tends steadily to increase in size. In such a pouch the urine stagnates and an encysted phosphatic stone is very liable to form.

Clinical Features. These are usually vague, the most common feature being for the patient to discover for himself that apparently after emptying his bladder of clear urine a further quantity of turbid urine will be passed if he presses in the suprapubic region. In some instances he will feel the distended diverticulum moving downwards while he passes his water. In other instances the only symptoms are difficult micturition or frequency as a result of a general cystitis which has been set up, while patients find that micturition is assisted by pressing in the suprapubic region. In some cases the only features are those of a persistent and unexplained cystitis.

Occasionally the surgeon can feel a soft fluctuating swelling which disappears on micturition at the side of the bladder on bimanual examination, while such diverticula occasionally project into an inguinal hernia (see p. 563). Stones are specially liable to form in them.

On cystoscopy the condition is generally obvious as a round dark opening leading into a black cavern, while a stone may be seen therein. Distension of the bladder with 13 per cent. sodium iodide solution will give a clear shadow of the diverticulum in an X-ray film.

Treatment. This consists in excision of the diverticulum with suture of the opening in the bladder. The wall of the bladder from which the diverticulum leads is dissected free; the bladder is opened, but not the peritoneum, and the diverticulum set free down to its neck. Care must be taken of the ureteric opening and the ureter itself. The diverticulum is removed and the opening into the bladder sutured with catgut stitches. Drainage will not be necessary unless oozing occurs or obstruction to micturition is present.

It must be remembered that in many cases the urinary outflow is obstructed, and an essential part in the treatment consists in the relief of this. Thus, in many cases, prostates will have to be removed or strictures dilated, and this may be done before or after the diverticulum is removed.

Intestino-Vesical Fistulæ. A fistula between the bladder and part of the intestine, most usually either the pelvic colon or the rectum, is a not uncommon and very distressing condition (p. 676). In some cases this condition is due to a malignant growth, either a primary growth of the bladder involving the rectum or pelvic colon secondarily, a primary growth of the bowel involving the bladder secondarily, or a growth of the prostate. A larger number of cases have occurred as the result of a diverticulitis of the pelvic colon which has become adherent to and opened into the bladder, while other cases have been due to a pelvic abscess, often from the appendix, which has opened both into the bowel and the bladder. Injury may be responsible in some instances, while the condition was a not uncommon sequel of the old-fashioned perineal cystostomy.

In this condition urine will pass into the bowel and be voided with the fæces; a more serious feature, however, is that gas, organisms and even fæcal matter will pass into the bladder, setting up an intense infection which is likely to spread to the kidneys. The patient will notice the gas escaping with his urine, and will complain that he is passing a fluid like ginger-beer, while the urine is brown and evil-smelling. Occurring as it does often in advanced malignant disease, the kidney infection usually will carry the patient off.

Treatment. This naturally will depend upon the cause, while it is all important, if possible, to do something in order to prevent the infection and fæcal matter from reaching the bladder.

In those cases which are due to an advanced malignant growth nothing can be done except to make a colostomy with a spur above the growth in order to divert the fæcal current, and this is nearly always worth doing.

In non-malignant cases it frequently may be possible to separate the bladder from the portion of bowel and sew up the openings in each, placing an omental graft between the affected viscera where possible.

A **vesico-vaginal fistula** is occasionally seen, there being a small opening between the bladder and the top of the vagina. Occasionally this is due to a syphilitic or malignant ulceration, but more commonly it is the result of a prolonged labour and the pressure of the fœtal head and forceps.

The urine continually runs away into the vagina, and the patient is persistently wet and miserable.

This condition can be cured by means of a small operation. The bladder and vagina are separated and the opening is sewn up.

Suprapubic fistulæ sometimes follow after operations such as prostatectomy. If the urethra is patent they nearly always will close spontaneously, and the first treatment, therefore, consists in the passage of sounds or the tying in of a catheter. Curetting the sinus sometimes will make it close, while if this fails, the tract should be dissected out and the bladder and layers of the abdominal wall sutured separately.

Bilharzia. This has already been described in Ch. VI., Vol. I. The bladder is often severely affected, bleeding ulcers and large masses of granulation tissue being formed, while cystitis, phosphatic concretions and pyelonephritis may follow.

Painless hæmaturia is the first symptom, and this disease always should be suspected in people who have lived in Egypt and the East. After a time the signs of cystitis or stone will set in. Cystoscopy will settle the diagnosis as red hyperæmic patches with white spots will be seen, while the ova can be found in the urine. The treatment is described in Ch. VI., Vol. I.

DISTURBANCES OF THE BLADDER FUNCTION

The function of the bladder consists in micturition, which is a complicated combination of processes, the outlines of which are given on p. 808. It will be remembered that urination consists of three chief processes, which are partly voluntary and partly reflex :—

(*a*) The distension of the bladder by urine gives rise to stimuli which pass up into consciousness by certain sensory nerves.

(*b*) A voluntary relaxation of the bladder sphincter occurs as a result of this.

(*c*) A voluntary contraction of the bladder is initiated which is assisted by contraction of the abdominal muscles, that portion of the bladder muscle employed being sometimes known as the detrusor.

Interference with function may occur in any of these three processes, and thus the states of incontinence, in which the urine passes away involuntarily, or retention, in which it cannot be passed, may be due to interference with the neuromuscular arrangements of the bladder, in addition to gross organic disease of the bladder and urinary passages. Control of the bladder is largely a matter of training: thus its function may be upset by diseases of the brain and spinal cord ; or, in cystitis, the desire for micturition may be so intense that even the trained mind cannot resist it, and the urine comes away.

Incontinence of Urine. This may be of several different kinds, the term denoting that condition where the urine runs away involuntarily without the patient being able to stop it, and, in some instances, without his being aware of it. It may dribble away either continuously or be passed in a stream in definite gushes at intervals. It is of two main kinds :—

(*a*) *True Incontinence* (*Passive Incontinence*). In this the sphincter of the neck of the bladder is relaxed or not functioning, so that urine flows out of the bladder as fast as it flows in and the bladder is always empty. This is often due to organic disease of the bladder or prostate by which the sphincter is mechanically prevented from acting and is seen in epispadias, ectopia vesicæ, etc. In women, it may be due to over-distension of the urethra, while it is not infrequently due to nervous causes.

(*b*) *False Incontinence* (*Distension with Overflow*). In this case there is an obstruction to the outflow of urine which is nearly but not quite complete. The bladder, therefore, becomes distended until the pressure is sufficiently great to cause the sphincter to give way and the urine to trickle out past the partial obstruction. This it continues to do involuntarily, while the bladder remains full. In most cases the distended bladder can be felt in the hypogastrium. This condition is especially seen in cases of stricture and enlarged prostate. In many injuries and diseases of the spine and nervous system a similar state of affairs occurs. Here the motor paralysis of the bladder renders it unable to empty itself, so that it fills up until the sphincter gives way under the pressure when dribbling commences. In these cases, either the motor or sensory side of the bladder function may be involved, so that the patient may know that his bladder requires emptying and be unable to do it, or he may not be aware of the distension of the bladder or of the urine running away.

In other cases, especially in injuries of the spinal cord, after some time what is known as an *automatic bladder* develops. In this case the bladder continues to fill up with urine until a certain degree of distension occurs, this usually taking two or three hours to accomplish. When the stimulus, of which the patient is quite unconscious, becomes sufficiently great, the bladder suddenly contracts and empties itself completely. In many instances the patients have discovered that when the time for the bladder to empty itself is drawing nigh, a slight peripheral stimulus such as tickling their thigh or pinching their buttock will precipitate the bladder action and cause it to empty itself. In this way, although their bladder is totally paralysed and insensitive, they can pass urine more or less when they wish to.

The treatment of an over-distended dribbling bladder is to empty it with the most complete aseptic precautions, either by catheterisation every five hours or by tying a catheter in which is connected to a suction apparatus. Such drugs as strychnine or ergot are valuable, while urinary antiseptics are essential. Unfortunately cystitis is almost certain to supervene sooner or later.

Retention of Urine. In this case the patient cannot pass urine and the bladder becomes distended ; the retention may be acute or chronic. In most cases this is due to a definite mechanical obstruction in the lower urinary tract, such as a growth in the bladder, impacted calculus, enlarged prostate, carcinoma of the prostate, urethral stricture or phimosis. In some cases the obstruction is due to congestion and spasm, as in acute gonorrhœa, while in women it may be due to derangements or changes in the uterus, such as a retroverted gravid uterus, impacted fibroids, etc.

When the condition is due to spasm of the sphincter in whole or in part, it may be relieved by such anti-spasmodic drugs as doryl or esmodil.

Another group of cases are due to disease of the nervous system, as already described ; thus organic disease of the brain or spinal cord or hysteria will cause it. A similar reflex condition is seen after operations on the lower abdomen, and for piles, hernia, varicocele, etc.

Minor degrees of retention are also seen in which the bladder can be only incompletely emptied and " residual urine " is left, while the condition must be distinguished carefully from suppression or anuria, in which no urine is secreted.

A minor degree of this condition known as *a stammering bladder* is sometimes seen in people of a somewhat nervous type who, though they can pass their water perfectly well and normally on most occasions, cannot commence the act satisfactorily or without much difficulty and straining, in the presence of others, and to whom the presence of a queue standing behind them in a public urinal and waiting to take their place proves an absolutely fatal bar to their relieving themselves.

Retention is also seen very occasionally in people who have been for some time in a position or place where they could not pass their water, so that the bladder becomes over-distended and atonic.

If retention of this kind is unrelieved, in some cases as already described distension of the bladder with dribbling overflow will ensue, while in other instances when there is an obstruction in the urethra, the urethral wall may give way above the obstruction, usually in the perineum, and extravasation of urine will occur. Occasionally the rupture will occur in the bladder, but this is rare.

It must be remembered that in retention the full bladder can be felt as a rounded dull suprapubic swelling, which disappears on catheterisation or suprapubic puncture. The only exception to this disappearance is when the bladder is full of blood clot.

Certain other functional disturbances of the bladder will be met with.

In *tabes* and *disseminated sclerosis* disturbance of the bladder function may be an early or late symptom. It usually takes the form of a recurring spasm of the bladder which gives rise to great urgency or frequency, sometimes bad enough to be called a "bladder crisis," while there may be difficulty in passing water, distension with overflow, or even true incontinence. In all cases of bladder disturbance, if no organic disease can be found in the urinary system, disease of the central nervous system should be the next thing to be investigated.

Hysteria occasionally affects the bladder of females. In most instances this takes the form of retention, but the bladder over-distension does not as a rule give rise to dribbling, as the patient will usually pass water before this occurs. Another hysterical manifestation seen in either sex consists in frequency with no cause, the patient passing water twenty or thirty times a day though during the night she sleeps all right: on examination both the urinary and nervous systems are perfectly normal.

Nocturnal Incontinence (Enuresis). This is a functional disturbance, whose origin is unknown, consisting of passage of urine at night while asleep. It is in no sense a dribbling incontinence, as the bladder definitely empties itself with a full stream. It occurs in small children, usually boys, and is often due to some incomplete lack of sphincteric control or to some increased excitement of the centres controlling micturition.

As a child grows he gains control of his bladder, first of all during the day, but it is not until some time later that he can sleep all night without passing water. Most children, however, should by the age of two or two and a half become dry at night, though boys may take a little time longer to settle down than girls. In the case of nocturnal incontinence this habit of wetting the bed at night quite unconsciously persists up to the age of six, eight, fourteen or even later, though control is usually perfect during the day. A few children exhibit the same phenomenon during the day.

In many cases a source of irritation is present; thus an acid urine, irritation of the bowel from worms, abundance of crystals in the urine (usually of uric acid), a rectal polyp, subacute rheumatism, adenoids, spina bifida occulta or phimosis and a tight foreskin are often present. In other cases there is no such cause, and if this is so it probably means that possibly as a result of an inherited nervous weakness the bladder is unduly sensitive or the sphincter is not strong enough to resist the intravesical pressure. Some cases may be regarded as being of an epileptic or choreic nature, while the condition exhibits a distinct tendency to disappear at puberty. It is common in mentally deficient children.

Some authorities distinguish five types of enuretics with their appropriate treatment as follows: (1) Those children in whom some palpable physical irritating stimuli exist, such as worms, overdistension of bladder, or cystitis; in these cases the treatment is obvious. (2) The hypersensitive or neuropathic type which responds to dietetic and medicinal measures, combined with readjustment of the environment and gentle re-education. (3) The so-called psychopathic child, in whom the enuresis is more a behaviour complex, and the treatment required is for the most part psychological. (4) Endocrine dysharmony, particularly hypothyroidism, leading to a loss of inhibition; in such cases small doses of thyroid with pituitrin as an adjuvant are indicated. (5) The debilitated child, often convalescent from some illness, for whom general tonic treatment is indicated. In all types atropin or belladonna is the specific drug of choice.

Treatment. If any organic cause such as phimosis, spina bifida, adenoids, highly-acid or crystal-containing urine, etc., is present, it must be removed, while the child should be waked from sleep at regular intervals to pass his water. He should have a hard bed, lie on his side, with a small evening meal and little to drink before going to bed, while it is sometimes advantageous to raise the foot of the bed. The general health should be improved in every possible way by tonics, cold baths, etc.

Many cases where no organic cause is detectable will be greatly improved by large doses of tincture of belladonna, and by increasing the dose gradually very large amounts will be tolerated. In other instances the administration of thyroid extract in small doses will produce a most remarkable improvement. In some cases improvement has been brought about by faradic electrical treatment applied to the bladder and pubes, by stretching the urethra by bougies or by suggestion. Above all, punishment should be avoided, as it is not the child's fault, and this tends to make the condition worse. The outlook is very poor in the cases where the mental condition is not very good; boys are not only more liable to the condition, but react better to treatment.

OPERATIONS UPON THE BLADDER

In nearly every operative procedure upon the bladder the first stage consists in opening the viscus; this may be done in two main ways.

(A) **Suprapubic Cystotomy.** This is by far the commonest and most satisfactory. A vertical incision is made in the midline passing through the linea alba immediately above the pubes. Variations of this, which are just as satisfactory, are a paramedian incision to one or other side or a transverse incision immediately above the pubes. The recti are separated or pulled aside and the extraperitoneal fat sought for. The bladder should have been distended previously with about 12 or 15 ounces of fluid, and on dragging the extraperitoneal fat upwards with the finger towards the umbilicus the reflection of the peritoneum where it passes from the anterior surface of the bladder to the anterior abdominal wall can be seen about 2 inches above the pubes. This is drawn up out of the way and the bladder wall will be exposed for an inch or two without any peritoneum in front of it. It can be recognised by its reddish-brown colour and the large veins on its surface. Two catgut stitches are then introduced into the bladder about an inch apart; it is held up by these and opened with a knife, the finger is introduced and the bladder explored.

Any operative procedure that is then required may be undertaken, *i.e.*, the removal of a stone, removal of the prostate, partial cystectomy, total cystectomy, etc. At the end of the operation the question will arise as to whether the bladder should be drained or not. If no cystitis is present and all bleeding into the bladder has been stopped there is no need to drain it. It is sewn up with one or more continuous catgut stitches and the abdominal wall is closed. A rubber catheter is tied in for four or five days, and when this is withdrawn the patient must be made to pass his water every two hours for some days more. He should be given large quantities of fluid and large doses of urotropin and acid sodium phosphate, to ensure that the urine is acid, so that phosphates do not become deposited on the catheter.

On the other hand, if cystitis is present, or there is likely to be bleeding or oozing into the bladder, drainage will be necessary. Merely for cystitis a small tube will suffice, a rubber tube of the type of Guyon's self-retaining tube being useful, but if bleeding is likely to occur a very large tube should be put in in order that blood clot may get up it and thus prevent the bladder becoming distended with clot. The wound in the bladder is sewn firmly round this tube and the rest of the abdominal wall closed. When the bladder is being drained, if a short tube is in, a Hamilton Irving's apparatus should be worn, as this will keep the patient and the bed dry, while if there is a long tube in the bladder this may be led over the edge of the bed to a suction apparatus, or it may pass under the surface of the water in a pail on the floor by the bedside. This will produce a syphon action and keep the bladder empty. The tube will be removed in four or five days, after which the Hamilton Irving's apparatus must be applied. In about ten days or so the patient gradually commences to pass his water by the urethra again, and after that the suprapubic wound will heal up rapidly.

In suturing any part of the bladder wall, catgut and not silk must be used, or stones will form on the unabsorbable material.

(B) **Perineal Cystotomy.** This operation used to be performed far more frequently than at present. It had the distinction of being the method by which Hippocrates cut people for the stone, but it is practically never used now.

The patient is placed in the lithotomy position and a grooved staff is passed into the bladder.

A little fluid is left in the bladder, an incision 1½ inches long is made in the midline of the perineum, stretching back to within 1 inch of the anus. The wound is deepened and the knife cuts down upon the staff, its blade incising the membranous urethra and entering the groove. The knife then passes backwards and upwards along the groove, incises the prostate and enters the bladder. The finger is then inserted and the bladder explored. The staff is withdrawn and a rubber tube inserted into the bladder through the perineal wound to provide drainage.

This operation is not easy and certain dangers are present. Thus hæmorrhage from the deeper arteries may be profuse; this may occur also from the prostatic plexus. The rectum may be injured if the knife leaves the groove or passes too far backwards. This usually comes as an unpleasant surprise one or two days later, when fæces come out of the wound, and it may result in a rectovesical fistula. Pelvic cellulitis is sometimes set up, and this may be accompanied by urinary extravasation. It will be seen, therefore, that the operation has grave disadvantages compared with a suprapubic cystostomy, the only virtue being that possibly drainage is better.

Cock's puncture and suprapubic puncture of the bladder. See p. 908.

Cystectomy. See p. 880.

Lithotrity. See p. 874.

CHAPTER XXI

INJURIES AND DISEASES OF THE MALE URETHRA AND GENITALIA

THE male genitalia may be defined as those organs concerned in reproduction, and consist of the penis and prostate, with the contained urethra, the testes and their coverings, the tunica vaginalis and the scrotum, and the epididymis, vas and seminal vesicles.

Anatomy. The **urethra** in the male is some 6 to 10 inches in length, and commencing at the internal urinary meatus at the base of the bladder, passes through the prostate, and thence traverses the triangular ligament lying in the perineum, where it becomes incorporated in the corpus spongiosum ; in this body it traverses the ventral portion of the penis, to emerge at the distal end of this organ at the external urinary meatus.

That part of the urethra lying in the corpus spongiosum is known as the *anterior urethra*, and is palpable throughout its course, though the posterior perineal portion lying in the erectile tissue of the bulb deep to the bulbocavernosus muscle is not easily palpable unless dilated by a sound. The anterior urethra terminates at the triangular ligament, where it narrows sharply, and is guarded, on the deep aspect of this tough fibrous septum through which the canal passes, by the compressor urethræ muscle, the reflex contraction of which shuts off the anterior from the posterior urethra, and constitutes a very definite barrier to the spread of infection backwards to the prostate. It is reflex spasm of the compressor urethræ that may hold up a rubber catheter during instrumentation.

The *posterior urethra*, which is anatomically continuous with the anterior, consists in front of the short narrow " membranous urethra " which lies in the opening through the triangular ligament and compressor urethræ, and this, the junction of the anterior and posterior urethræ, being the narrowest part of the canal, is the place where the effects of fibrous contracture following ulceration are first noticed, and is thus the commonest site of " *Stricture of the urethra*." The urethra then bends upwards and enters the prostate, which it traverses to the floor of the bladder, its internal meatus being guarded by the internal sphincter muscle which normally lies above the capsule of that gland. This part of the posterior urethra is very wide and will accommodate easily the index finger introduced from the bladder ; it becomes elongated and distorted in enlargement of the prostate (p. 919). The *prostatic urethra* is crescentic in outline, having a ridge running vertically down its posterior wall (the Verumontanum or Crista Galli), on the summit of which opens the tube-like sinus pocularis leading to the rudimentary uterus masculinus (developmentally the fused lower ends of the Mullerian ducts, which represent the vagina and uterus in the female). On either side of the Crista Galli is a sulcus into which open the ducts of the prostate and the common ejaculatory ducts from the testes and vesiculæ seminales. Irritation of the sensitive mucosa produces a strong and persistent desire to micturate.

Throughout the length of the urethra, especially in the dorsal surface of the penile portion, numerous minute tubular glands (Littré's follicles) open into the canal, and their mouths can be readily seen on urethroscopy.

The **urethroscope** is a tubular instrument, fitted with an obturator for introduction, which thereafter is withdrawn to allow the insertion of a small electric light. To this a bellows can be fitted to dilate the urethra as required, and through such an instrument the anterior and, less easily, the posterior urethra can be inspected readily and treatment carried out as required.

Sounds or Bougies are made of gum elastic, or more often metal, and are solid rods used for " sounding " the urethra to ascertain its patency or the presence of foreign bodies or obstruction in the canal itself or in the bladder (q.v., p. 873). Such instruments are usually curved at the tip, but may be straight, and as they must be passed entirely by touch, require skill and gentleness in their manipulation in order to prevent damage to the mucous membrane, or their passing through the urethral wall into surrounding tissues (*false passage*). Of the curved sounds those most used are (*a*) Clutton's, which are graduated in millimetres, showing the circumference at the tip and shoulder ($\frac{18}{22}$), and (*b*) Lister's, which have an acorn tip. In passing such an instrument it is well to commence with one of moderate size (Clutton $\frac{14}{18}$), so as to avoid the risk of the point catching in Littré's follicles in its passage; the point of the sound must be kept in the midline against the dorsal aspect of the urethra, and manipulated through the triangular ligament and under the pubic arch by depressing the handle, after which the instrument can be felt to glide into the bladder, when it can be rotated freely.

Catheters may be of rubber, gum-elastic, or metal, and are hollow tubes designed to pass through the urethra to withdraw urine from the bladder.

The **penis** consists of a fleshy organ 4 to 10 inches long, which is composed of three masses of vascular erectile tissue and ensheathed in a loose covering of skin, the redundant anterior portion of which is reflected backwards over the glans penis behind the corona, to which it is attached. This redundant skin (*prepuce or foreskin*) varies much in length in different individuals, and is normally mobile over the glans (except on the ventral aspect, where it is attached by the frænum), from which it can be retracted; if very redundant and not easily retracted, *phimosis* is said to be present.

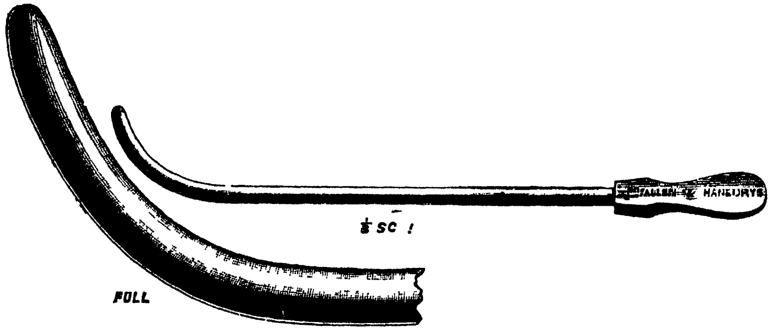


FIG. 295. Clutton's Sound.

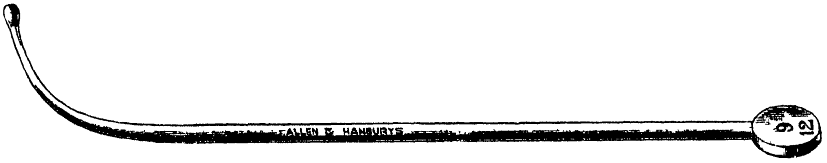


FIG. 296. Lister's Sound.

The erectile tissue is arranged in two corpora cavernosa, which arise from the subpubic ramus on either side and pass forward, lying side by side, on the dorsal aspect of the penis. On the ventral aspect, and ensheathing the urethra, is the more vascular corpus spongiosum, the distal end of which is expanded and curved backwards to cover the ends of the corpora cavernosa and constitutes the sensitive glans penis

The *blood and nerve supply* of the penis, urethra, and prostate is very free, and derived from the internal pubic vessels and nerves, with which are associated many sympathetic fibres from the pelvic plexus via the nervi erigentes.

The *lymphatics* of the penis and anterior urethra drain into the inner transverse group of the inguinal nodes, while those of the posterior urethra and prostate pass up to the iliac and aortic nodes within the abdomen. The scrotal lymphatics drain to the inguinal nodes, while those from the testes and epididymis pass up to the aortic nodes.

The **prostate** is a gland shaped like an inverted chestnut and much the same size, which is applied to the base of the bladder around the prostatic urethra, into which its numerous ducts open. The gland consists of two lobes, which are situated mainly laterally and posteriorly to the urethra and united across its anterior aspect largely by fibrous tissue; hence any neoplasm in the gland will develop posterolaterally to the canal, the posterior wall of which becomes elongated, as the neoplasm follows the line of least resistance and enlarges up into the bladder.

For this reason the prostatic urethra appears elongated and bent on itself at a right angle, thus constituting a mechanical obstruction to forcible attempts at micturition.

The lobes are traversed on either side, from behind, forwards and inwards, by the common ejaculatory ducts, which cut off a wedge-shaped mass from each lobe which, if enlarged, constitutes the so-called "middle lobe" of the prostate. This area is the favourite site for the development of adenomata. The whole gland is surrounded by a dense fibrous capsule, derived from the pelvic cellular tissue, in which lies a large plexus of thin-walled veins (prostatic plexus) into which drain the dorsal vein and erectile tissue of the penis.

Examination of the prostate can be performed easily by digital palpation through the rectum, when in the adult male the gland is felt as a smooth rounded mass, with a small median longitudinal sulcus, and bounded laterally by two deep sulci. The whole is even and elastic to the touch, and the rectal mucosa moves freely over it, a most important point to ascertain, as fixity indicates malignant disease or inflammation of the organ. Before puberty no prostate exists which is palpable, and thereafter it gradually increases in size till about fifty, after which the organ may enlarge rapidly or retrogress and become small, hard and fibrotic.

The **testes**, two in number, lie side by side in the scrotum; each testicle consists of an ovoid, pinkish, glandular mass enclosed in a firm fibrous capsule, the tunica albuginea. The glandular tissue consists of two elements: (*a*) that producing the external secretion, spermatozoa and semen, which consists of masses of closely-packed convoluted tubules (seminiferous tubules), which fuse together as they converge to the rete testis on the centre of the posterolateral surface; and (*b*) a series of small islets of solid cellular tissue, which are concerned with the internal secretion of the testes.

Around the postero-external aspect of the testes runs the rounded **epididymis**, which expands above into the globus major and below into the globus minor, both of which are closely apposed to the tunica albuginea testis. Between the extremities the epididymis is only attached posteriorly where the seminiferous tubules leave and blood vessels and nerves enter the testis (*rete testis*), antero-external to which lies the pitlike digital fossa between the testis and epididymis.

At the rete testis the seminiferous tubules, some five or six in number, pass into the epididymis and, fusing to form two or three larger tubes, they pass upwards around the globus major, and so down the body of the epididymis to the globus minor, from the posterior aspect of which emerges the vas deferens, into which the ducts pass.

The **vas** is a thick-walled white tube, easily palpable through the skin, which at first passes up the posterior aspect of the testis outside the reflection of the tunica vaginalis, lying posterior to, but in close association with, the other structures of the spermatic cord.

Together with the pampiniform plexus, spermatic artery, deferential artery, and genital branch of the genitocrural nerve, encased in cellular tissue and the loops of the cremaster muscle, which structures form *the spermatic cord*, the vas traverses the scrotum and the inguinal canal to the internal abdominal ring. Here the vas leaves the other structures, which pass upwards behind the peritoneum and, accompanied only by the deferential artery, dips down into the pelvis, where it crosses the ureter, lying between this and the peritoneum, to pass between the base of the bladder and the rectum. At this point the vas lies internal to the flattened and convoluted vesicula seminalis, with which it communicates, and which acts as a reservoir for the semen; thence it becomes the common ejaculatory duct and penetrates the posterosuperior aspect of the prostate, which it traverses, to open into the prostatic urethra in the sulcus beside the verumontanum.

The tunica vaginalis is a serous sac, originally derived from the peritoneum. This is reflected around the front and lateral aspects of each testis and epididymis which, except at the posterior aspect, where the vas and vessels enter and leave the gland, lie in a serous sac lubricated by the secretion of its endothelium. The visceral layer of the tunica is tightly attached to the tunica albuginea and epididymis, while the parietal layer lies against the scrotal cellular tissue. The potential space between these layers may become distended with exudate under certain conditions, when a hydrocele of the tunica vaginalis results.

The spermatic cord, so named from its feel when palpated through the scrotum or by passing a finger into the inguinal canal, consists of the various structures enumerated, loosely held together by fascial sheaths derived from the cellular tissue of the abdominal muscles (internal spermatic, cremasteric, and external spermatic fasciæ) and the loops of the cremaster muscle, derived from the lower edge of the internal oblique muscle, which serve to retract the testicle, and can in a child hoist it into the inguinal canal.

The main bulk of the cord is made up of the **pampiniform plexus** of veins, which drain up to the spermatic veins and are arranged in a larger anterior mass and a smaller posterior group around the vas. The right spermatic vein drains into the inferior vena cava, and the left into the left renal vein, which it enters at right angles.

A varicose condition of the pampiniform plexus constitutes a varicocele.

The vesiculæ seminales consist of two elongated and flattened masses of convoluted tubes situated on either side of the posterior surface of the bladder, and in close apposition to both this viscus and the rectum. They converge below and each opens into the corresponding vas deferens, which lies to the inner side, this union resulting in the formation of the common ejaculatory duct on each side. The vesiculæ can be palpated easily on digital examination of the rectum, diverging upwards and outwards from the midline, above the upper margin of the prostate. Their contents can be expelled easily by pressure directed from the sides to the centre of the anterior rectal wall.

Development and Descent of the Testes. An elementary knowledge of the descent of the testes serves to explain the presence of the tunica vaginalis, the sacs of inguinal herniæ (Chapter XIV., p. 581), and encysted hydrocele of the cord, besides accounting for malposition and imperfect descent of the testis, and the presence of teratomata and hypernephromata in that organ and along the course of the spermatic vessels.

The testis on each side is developed in the retroperitoneal tissue of the lumbar region from a ridge of mesoblastic tissue (*genital ridge*) which develops to the inner side of the *Wolffian* body and projects forward into the cœlomic cavity, the peritoneal lining of which invests the anterior lateral aspects of the ridge. From this covering columns of cells grow into the mesoderm, and later form the seminiferous tubules which acquire a secondary connection with the *Wolffian* duct, running along the dorsal aspect of the ridge, from which the vas deferens is developed.

From the lower end of each genital ridge a strong band of fibromuscular tissue (the *gubernaculum testis*) passes down to be attached to the region of the sacroiliac joint; then it passes to the internal and external abdominal rings, and thence normally to the bottom of the scrotum. This structure pulls the testis down into the scrotum, but should the lower end fail to develop, the descent may be arrested anywhere along its course (*undescended testis*); or should abnormal lower attachments occur, as into the crural canal, perineum, or abdominal wall, a misplaced or *ectopic testis* will result.

Moreover, as already discussed in Chapter XIV., in connection with inguinal hernia, the peritoneum where it is attached to the genital ridge gets pulled down in a tube-like process behind the general peritoneal cavity; this process is at first patent (*processus vaginalis*), but normally becomes obliterated above, and persists around the testes as the *tunica vaginalis*. Should it remain patent throughout or above the tunica vaginalis, a hernial sac will result; while if it is shut off both above the tunica and from the peritoneal cavity, it will persist along the middle part of the cord, when it may distend to form a hydrocele of the cord.

INJURIES AND DISEASES OF THE URETHRA

Congenital Abnormalities. The urethra rarely may be entirely absent, but is more often *occluded by a septum* which may be situated behind the navicular fossa or in the perineum (congenital stricture). The condition is usually associated with a patent urachus, through which the urine escapes at the umbilicus (Chapter XIII., p. 528), or there is a communication between the bladder and rectum. Should neither of these exist, then the child if born alive dies in a few days, unless the septum is divided and the urethra kept patent by the passage of sounds.

In such cases the bladder is much hypertrophied and can be felt distended above the pubes, while the ureters are much dilated and communicate with bilateral hydronephroses (Chapter XX., p. 823).

Very occasionally a *bifid urethra* is present; the second canal, usually opening along the ventral surface of the penis, can be dissected out easily, and its communication with the main urethra crushed and ligatured.

Hypospadias is a condition in which the floor of the urethra is more or less deficient, due to failure of the internal genital folds to fuse, with the result that the external meatus opens somewhere on the ventral aspect of the urethra or in the perineum. The condition is always associated with the presence of a ventrally incomplete and rudimentary prepuce, which forms a "hood" over the glans penis; in the more severe forms of hypospadias the penis is often rudimentary and deformed, while the testes are often undescended and the scrotum ill-developed, so that the genitalia, and indeed the general appearance of the patient, approach the female in type.

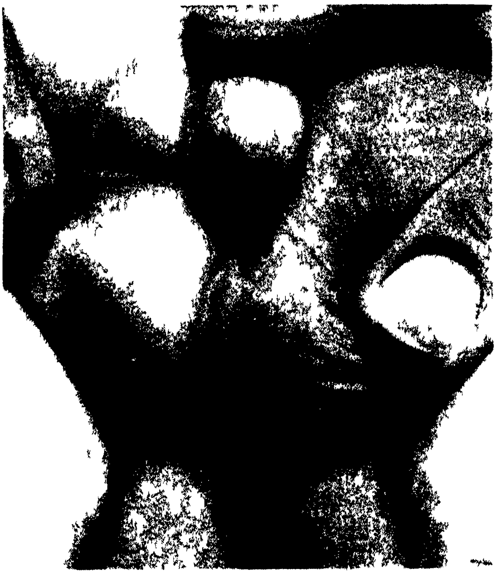


FIG. 297. Penile hypospadias with urethral opening at the root of the penis.

Three types of the condition are recognised clinically :—

(1) *Glandular hypospadias* is the mildest type and is surprisingly frequent, if careful examinations are made, though, owing to the slight disability and the presence of a dimple in the normal position of the external meatus, the condition is often unrecognised. In this variety the urethral opening, which is often small, is situated in the place where the frænum should be.

The condition is of no importance, but may cause difficulty to a surgeon if he attempts instrumentation, either from attempted passage down the blind dimple in the normal meatal situation, or from the narrowness of the urethral orifice.

No treatment is advisable in this variety of hypospadias.

(2) *Penile hypospadias*, in which the urethral orifice is situated somewhere along the ventral aspect of the penis in front of the scrotum. If near the glans, there is often a groove leading across the ventral aspect of this structure

from the normal meatal site to the urethral opening. The orifice is usually minute, so that the urethra may distend behind it during micturition, during which the stream often sprays back and soils the clothing. This is further aggravated by the ventral incurvation of the smallish penis, a deformity due to the presence of fibrous bands in the front end of the corpus spongiosum; these often so seriously interfere with erection that coitus is not possible and insemination impracticable.

As these patients are often otherwise normally developed, operative procedures are justifiable to attempt correction of the deformity; these should be carried out before puberty, but are by no means always successful.

When a fibrous cord is present beyond the meatus it must be divided transversely, and the wound having been sewn up longitudinally, the penis is splinted by strapping it to the abdominal wall. Later, *i.e.*, in about a month or six weeks, attempts may be made to elongate the urethra either by plastic flaps from the penile skin, or tube grafts from the abdomen or the redundant hooded prepuce, which can be passed down through a cannula inserted through the glans penis.

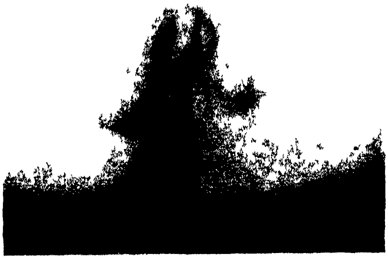


FIG. 298. Complete hypospadias. Note the rudimentary genitalia resembling the female in appearance.

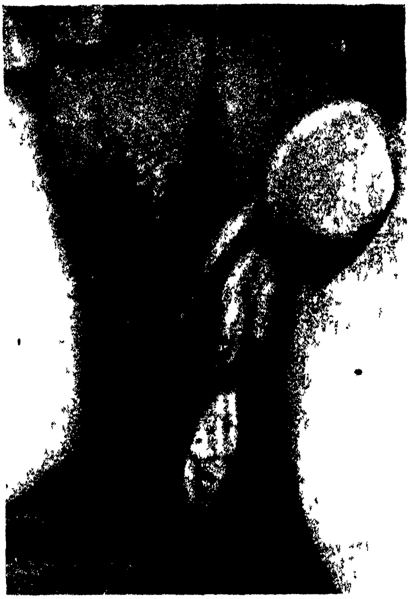


FIG. 299. The same case as Fig. 298 at the age of 18 years.

It is advisable to divert the urine by performing a suprapubic cystostomy, which is kept patent till healing of the penis has occurred. Great patience and often several operations are necessary to secure a good result, and the percentage of failures is large, even when the operations are undertaken by an experienced surgeon, union being very difficult to obtain between the ends of the graft and the urethra.

(3) *Perineal or scrotal hypospadias* is practically always associated with undescended testes and a rudimentary incurved penis, so that the genitalia closely approximate the female in appearance, and such children are often regarded and even reared as girls.

This mistake can be avoided by a careful inspection, as, of course, no vagina is present, unless, as is rarely the case, true hermaphroditism has occurred. The condition calls for no surgical interference.

Epispadias may be defined as the reverse of hypospadias, the urethra opening on the dorsal aspect of the penis (p. 860, Fig. 289). Some authorities regard it as due to deficiency of the dorsal wall of the urethra, and others as being a condition of hypospadias, in which the whole penis is so twisted that the corpus spongiosum has come to lie on its dorsal aspect. Whichever is correct, the whole penis is always very rudimentary and much deformed and the testes generally undescended, while ectopia vesicæ (Chapter XX., p. 859) and absence of the pubic symphysis are always associated with complete epispadias.

Partial epispadias is uncommon, the urethra usually opening on the dorsum of the penis just beneath the symphysis pubis, but very rarely a penile or glandular epispadias is seen. This may occur with or without separation of the pubes. There is control of the passage of urine, and plastic operations may be undertaken to close in the canal, the flaps usually being turned over from the side of the penis. In the more common case, where the epispadias is complete, there is total lack of urinary control and the condition is practically an ectopia vesicæ. The best treatment is then a transplantation of the ureters (see p. 860).

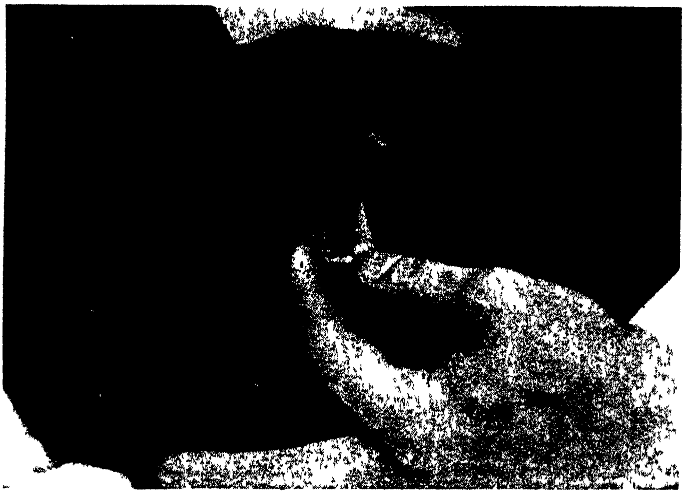


FIG. 300. Complete hypospadias.

Injuries of the Urethra. The urethra may be subject to trauma from wounds, crushing accidents, usually associated with fracture of the pelvis in the region of the pubes, or self-mutilation and the introduction of foreign bodies.

(1) **Wounds of the urethra** may result from stabs or gunshot injuries, when the injury is often of a "raking" type, and there is usually considerable damage and disruption of the penis and scrotum, often with destruction of the testes. The wounded urethra, in so far as possible, should be sutured around a catheter passed into the bladder, and this must be left in situ until the wound has granulated.

(2) **Rupture of the urethra** is the term applied to tearing or crushing of the canal which results from violence applied to the perineum, as from a kick

between the legs or falling astride a fence or bar, or from laceration complicating fracture of the os pubis of the pelvis, which may result from crushes, and is frequent in hunting accidents. The urethra may be severed partially or completely, and in the former case it is usually the dorsal wall that remains intact. The rupture occurs in the perineal portion of the canal, usually at the junction of the membranous and penile portions, *i.e.*, where the urethral walls are attached to the rigid triangular ligament. The condition is almost confined to males.

Clinically there is always bruising, marked swelling and tenderness in the perineum, and if the pelvis be fractured the legs will be held motionless, everted and somewhat abducted and flexed, while other signs of fracture will be present (Vol. I., Ch. XVII.). Generally some drops of blood escape or can be expressed from the external meatus, and the hæmorrhage may be bright red and brisk if much laceration has occurred. There may be a strong desire to micturate, but should this be present with the above signs, every effort should be made to persuade the patient to hold his water, otherwise " extravasation of urine " will result (Chapter XXI., p. 896).

Should the patient attempt to micturate, a poor stream may be passed, but the perineal swelling will be seen to increase in size, and a dull aching will be complained of due to pressure in that situation. Sometimes the pressure of the extravasated blood is so great that the urethra is obliterated, and the patient cannot pass water; this is much more likely to occur where the urethra is "*contused*," as here there is no passage for escape of the extravasated blood. A rough distinction between rupture and bruising of the urethra may be made by the fact that in the former condition there is profuse external bleeding, and a catheter usually cannot be passed, whereas in the latter there is little or no external hæmorrhage and a catheter usually can be passed.

Both rupture and contusion of the urethra are often accompanied by great shock, even when no bone is fractured, and this sign occurring with perineal injuries always should lead the surgeon to suspect urethral injury, and the case to be investigated carefully from this point of view. As the injury is distal to the sphincter, no extravasation of urine will occur unless the patient passes water, and should extravasation be present when the patient has not tried to urinate, then either the whole urethra has been torn from the bladder, an accident by no means rare after perineal injuries, or there is a wound of the extraperitoneal portion of the bladder (see p. 861). Both these conditions usually occur as complications of a pelvic fracture.

Treatment. If damage to the urethra is present or suspected, an attempt should be made to pass a suitably-sized rubber catheter (about Nos. 9–11 are the general sizes suitable for an adult), and if this succeeds, the urine will flow out and the catheter should be left in situ. If the catheter cannot be passed, as is likely in all cases where actual rupture has occurred, an anæsthetic must be given, and, the patient having been placed in the lithotomy position, the urethra is cut down on through the median perineal raphé and exposed. Under the anæsthetic it may be possible to pass a soft or silver catheter, and if this can be done it should be left in while the incision is made, as its presence greatly facilitates the exposure of the damaged urethra. The divided ends of this are identified and sutured around the catheter, when if this is of silver it should be withdrawn and a soft rubber one substituted.

Only catgut must be used for suturing. All blood clot is then removed, bleeding points ligatured and the wound loosely closed with salmon-gut stitches passing deeply through the tissues. Many surgeons are of the opinion that a procedure of this kind should always be accompanied by a suprapubic drainage of the bladder.

The catheter, if possible, should be left in for a week or ten days, but seldom can be tolerated in children or young adults for more than half this time. After its withdrawal it is again passed daily, while at the end of three weeks a less frequent instrumentation is necessary for some months to prevent formation of a " traumatic stricture " (p. 903).

When a catheter cannot be passed into the bladder it should be introduced down to the laceration during the operation, when the dorsal urethral wall may be seen to be intact, and serve as a guide to the posterior end of the torn urethra.

In late cases, where extensive extravasation has occurred, it may be impossible to identify the urethra, and then the wound will be left open and the urethra subsequently sought for and united, if possible, as soon as the extravasation has subsided.

Often, especially in these cases, " retrograde catheterisation " from the bladder, through a suprapubic cystostomy wound, may be of great assistance in identifying the posterior end of the torn urethra.

Many ingenious devices have been practised for dealing with ruptured urethra. For instance, a metal sound with a cupped end may be passed down the urethra from a suprapubic wound and another sound with a round tip is passed up the urethra. The two are made to meet and fitted together (without any perineal incision) and the two sounds are then withdrawn as one instrument, pulling a catheter after them.

Rupture of the Bulbo-Cavernosus Muscle occasionally results from trauma in the male perineum and may follow imperfect union of the fibres after a ruptured urethra. The patient complains of urine dribbling at the end of micturition, and examination digitally of the perineum reveals a gap in the muscle.

Treatment consists in instructing the patient gently to squeeze the perineum to expel the last drops of urine. Cicatrisation occurs in about two months and control is re-established ; no operative interference is indicated in these cases.

Extravasation of Urine may result from rupture of the neck or extraperitoneal portion of the bladder, from rupture of the urethra, or follow the passage of sounds for the treatment of fibrous stricture. The urine escapes between the triangular ligament and Colles' fascia, the attachment of which prevents the fluid passing back to the ischio-rectal fossæ, and directs it forwards along the perineum to the scrotal and penile cellular tissues and thence to the abdominal wall, deep to Scarpa's fascia. The attachments of the latter to the fascia lata just below the inguinal ligaments stop the urine passing down into the thighs.

Clinically there is pain in the perineum following a history of trauma or instrumentation. There may be urethral hæmorrhage, and some urine may be voided, but the stream is poor. First the perineum and then the scrotum and penile coverings become swollen and boggy, while later this condition spreads up on to the abdominal wall. In neglected cases sloughing of the distended skin may occur with escape of uriniferous fluid. The patient is ill, the temperature high, and the tongue furred.

Treatment consists in prompt incisions through the fascia of Colles and Scarpa to allow escape of urine. Later a catheter should be passed, if possible and left in situ, or an operation must be undertaken to suture the torn structures. Baths should be given daily, and the wounds dressed with cyanide gauze between whiles. Urinary antiseptics, as advocated on p. 868, must be administered freely.

(3) **Foreign bodies** are not infrequently introduced into the urethra by the sexually minded and the insane, while occasionally the end of a catheter may break off and be left in the canal. Slate pencils, pipe-stems, pins, clinical thermometers and sticks of cordite from rifle cartridges have all been found in this situation. Such bodies usually can be palpated in situ, or their position located by the passage of a sound, while a history is usually forthcoming. There is, moreover, a partial or complete blockage of the urinary stream, while if the body has been present any time a mucopurulent urethritis may be present, which must not be mistaken for gonorrhœa. If left in situ these will produce ulceration, with periurethral abscess; this often bursts and discharges and gives rise to a urinary fistula, which usually evacuates the foreign body.

Urethroscopy and X-ray films are helpful in diagnosis in some cases.

Treatment. Prompt removal is indicated, and to achieve this safely urethroscopy is necessary, the foreign body being seen, grasped with forceps and withdrawn through, or together with the urethroscope. Should this instrument be unavailable, however, removal may be gently attempted with forceps if the body is near the meatus, or attempts may be made to express rounded objects such as beads or peas.

No prolonged efforts, and certainly no violence, should be used, as great damage to the urethra may occur, with subsequent formation of a stricture. It is better to anæsthetise the patient and cut down through the corpus spongiosum, opening the urethra longitudinally over the foreign body, which is grasped and withdrawn; the urethra is sutured with catgut, hæmostasis secured, and the skin sewn up.

Regular instrumentation should be carried out to prevent stricture formation.

In the case of a pin, often withdrawal may be carried out by pushing the point through the urethra and skin, pulling it out to the head, and reversing this so that it points to the meatus; the whole pin is then pushed back and the head guided to the meatus, when it can be withdrawn.

Urethral Calculus. A renal, vesical or prostatic calculus may be passed through the urethra without the patient's knowledge, until it tinkles into or is noticed in the urinal, or its passage may cause a certain amount of pain and strangury. Occasionally, usually in children, such a stone may become impacted in the urethra.

Impaction may occur (1) at the junction of the prostatic and membranous urethra, when the stone is fairly large, and, as it here lies in the sphincter, dribbling incontinence often results. If it has passed below the sphincter, however, retention due to obstruction and spasm will occur. In south-east Europe, Egypt and India, where vesical calculus is common, it is not infrequent to meet with large stones occupying most or all of the bladder, and with a projection passing down into the prostatic, membranous, and even penile urethra, when it is palpable through the perineum.

(2) In the penile urethra, when the stone is not infrequently held up in the fossa navicularis, and can be seen at the external meatus. If impacted further back it can be palpated, seen through the urethroscope, and detected by X-ray films. In this situation there may be retention in children, and

pain on micturition in adults, while if the stone has been present for some time purulent urethritis is common.

In both varieties there is usually a history of recent renal colic, and hæmaturia may be present.

Treatment. Stones in the prostatic urethra should be treated as vesical calculi, and removed by suprapubic cystotomy or lithotrity.

Stones in the penile urethra of an adult often will be passed naturally if an injection of atropine sulphate gr. $\frac{1}{100}$ and morphia gr. $\frac{1}{8}$ be given, and the patient sat in a hot bath to allay pain and spasm. If these means fail, and always in children, removal must be carried out; this is best done under general anæsthesia, though a local anæsthetic may suffice in adults.

Attempts at removal by forceps are seldom successful, as the stone slips away and tends to fragment, and the best instrument is a blunt Volkman's scoop which can be introduced alongside the stone and hook it forwards.

If the stone is at the meatus this can be carried out easily and the stone be removed, as it can also from deeper in the urethra if a urethroscope is available. In stones which are not visible it is better to cut down and remove them than to carry out blind attempts at instrumental removal.

INFECTIONS OF THE URETHRA : URETHRITIS

Infections of the urethra are commonly due to bacteria introduced through the meatus, usually from impure sexual connection, but occasionally by the passage of an unclean instrument, or the introduction of a foreign body. We can recollect one case of severe B. coli urethritis in a medical student who, having taken his rectal temperature, introduced the thermometer, without any cleansing, into his urethra, in order to observe if any difference of temperature existed in that canal.

(*a*) **Simple or mucoid urethritis** is an extremely rare condition, apart from a chronic gonorrhœal infection, but it may be met with occasionally as a result of instrumentation, oxaluria or the presence of a foreign body or calculus in the urethra. There is a discharge of thin mucus which tends to accumulate around and gum up the urethral orifice. In any such case it is essential that a smear be examined bacteriologically in order to eliminate chronic gonorrhœal infection.

(*b*) The gouty or alcoholic urethritis described by the older surgeons was probably not anything other than exacerbation of a chronic gleet from gonorrhœal prostatitis, but occasionally an oxaluria may be present (p. 839).

A true mucoid urethritis will subside as soon as the irritant is removed, and calls for no other treatment. It readily passes into a purulent urethritis if the cause of irritation, such as a catheter tied in the urethra, is allowed to remain.

(*c*) *Gleet* is always the result of old and persistent gonorrhœal infection in the urethral crypts, prostate, or vesicles, and is characterised by a sticky mucoid discharge, most marked in the morning on rising, " bonjour goûte." The condition is fully dealt with in Vol. I., Ch. VI.

(*d*) *Purulent Urethritis.* The urethra is very resistant to infection by most pyogenic organisms, and urine from the bladder heavily infected with staphylococci, B. coli, and B. tuberculosis may be voided for months without any urethral infection resulting. On the other hand, infection via the meatus with dirty instruments and during impure sexual connection, especially if abrasion of the mucosa occurs, is by no means uncommon.

The most frequent cause of purulent urethritis is the *gonococcus* of Neisser, which is capable of penetrating the undamaged epithelium and causing an intense purulent urethral discharge in from one to three days after infection. Gonorrhœal urethritis and its complications are fully discussed in Ch. VI., Vol. I., but it is well to remind the reader that the discharge usually ceases with the onset of local complications, though the meatus looks red ; and that the commonest cause of a chronic mucoid urethral discharge, which often exacerbates as a result of illness or excesses, is a chronic gonorrhœal infection.

In all cases of urethritis smears must be taken on a sterile platinum loop, stained, and examined microscopically, when in the vast majority of cases the Gram-negative bun-shaped intracellular *gonococcus* will be discovered.

In a few cases, however, other organisms will be found, and of these the commonest are :—

(1) *B. coli.* B. coli urethritis is most often seen in elderly men (apart from women, where it occurs as a direct infection), but may be met with at any age, and is often due to infection during sexual malpraxis. The condition often can be recognised by the nature of the discharge, which is thin and seropurulent, in marked contrast to the creamy, yellowish white pus of gonorrhœa. Epididymo-orchitis is a by no means uncommon complication, and is extremely painful and very liable to result in sloughing of the testis, which needs removal in this case. Bladder and even renal infection may occur.

Treatment consists in giving large doses of sodium bicarbonate or potassium citrate, combined with infusion of buchu, so as to ensure a copious alkaline urine ; if bladder or renal infection is present, helmitol, grs. x t.d.s., is of value. Vaccines often may give good results in intractable cases, while ketogenic diet is worth a trial.

Irrigation and other forms of local treatment are to be avoided, as they are likely to spread the infection.

(2) *B. proteus vulgaris* produces a foul brownish white pus ; it results from the same causes as B. coli, and merits similar treatment.

(3) *Staphylococci* of various types produce a yellowish white purulent discharge, usually without the pain and strangury associated with a gonorrhœal infection. This usually results from the presence of a calculus or foreign body in the urethra, or the presence of a catheter, the removal of which source of irritation is followed by rapid cessation of the discharge.

No other treatment is usually required, but gentle irrigation with permanganate of potash or boric lotion is permissible, and diuretic mixtures may be administered.

Periurethral abscess is most often met with in the perineum, but may occur around the penile urethra. The infection usually comes from the urethral canal, and may occur following ulceration (1) around a foreign body, (2) behind a stricture, (3) from urethritis, (4) from instrumentation, especially if a " false passage " has occurred, (5) rarely from carcinoma of the urethra.

Clinically a painful indurated swelling appears, and can be felt around the urethra in the affected area. This gradually increases in size, shows signs of acute inflammation, becomes boggy, and ultimately fluctuates. If situated beneath the deep fascia of the perineum, it may cause acute pain, retention of urine and rigors, closely simulating a prostatic abscess.

If left, the abscess may point into the urethra or on to the surface of the body, or in both directions, when the pus will be evacuated and " urinary fistulæ " often result.

Treatment consists in early and adequate incisions through the skin along the course of the urethra to secure evacuation of the pus to the exterior.

Passing a sound in the hope of bursting the abscess into the urethra is not to be advocated, as the drainage is seldom adequate.

Hot baths are to be recommended to ease pain both before and after operation. Should retention occur a soft catheter may be passed or a supra pubic puncture carried out.

Urethral fistulæ (urinary fistulæ), whence urine only flows during the act of micturition, usually result from the improper drainage of a periurethral abscess, and are often multiple in number and occur through a hard mass of inflammatory tissue resulting from the chronic infection in and around their tracks. They are most often met with in the perineum, but may occur in the penis; they are often multiple, and during micturition the urine may spray out as from the rose of a watering can.

Such fistulæ are most often seen in elderly men, and usually result from :—

(1) Periurethral abscess.
(2) Stricture of the urethra.
(3) Prostatic abscess.
(4) Carcinoma of the urethra, prostate or rectum.
(5) Perirectal or ischio-rectal abscess.
(6) Gummatous infections around the rectum, perineum and penis.
(7) Extravasation of urine (usually behind a stricture, but also in a ruptured urethra).

The diagnosis is obvious, and as the semen also escapes through the fistulæ the patient is usually sterile. In cases where the rectum also is involved fæcal discharge will be present from some or all of the fistulæ, so that the urethral element may escape notice.

Treatment is both difficult and, in many cases, unsatisfactory. In the first place, any obstruction to urinary outflow must be removed, and as in most cases a stricture is present, often aggravated by the fibrosis in and around the fistulous tracts, sounds should be passed regularly. In slight and early cases this may enable the fistulæ to heal, but if extensive fibrosis and many tracks exist, these must be laid open freely and curetted. This must be done always if fæcal fistulæ coexist. In gummatous cases antisyphilitic treatment must be carried out in conjunction with local manipulation. Carcinomatous cases call for no local interference, as nothing can be done to alleviate the advanced local growth which will be present, and all that can be achieved is to make the patient as comfortable as possible.

Tumours of the urethra are very rare.

(*a*) A **hæmangioma** may occur as a diffuse mass along the length of the urethra or as a localised nævus, when it may cause persistent bleeding. If local it can be excised; otherwise the urethra should be laid open, the mass cauterised with the diathermy apparatus and the urethra sutured.

Occasionally a painful granulomatous mass, which bleeds readily and causes much strangury, is met with at the external meatus, usually in very old men. It is comparable to the urethral caruncle met with in elderly women, and, like it, is best removed by diathermy.

(*b*) **Carcinoma** is rare, apart from penile carcinoma; it may, however, start as a primary growth, either in the penile or membranous urethra, when a squamous-celled carcinoma is usual, but a columnar-celled growth may be met with in connection with a tumour arising in Littré's follicles.

Clinically the disease occurs in elderly men, who usually notice difficulty in micturition and hæmaturia. Blood may run away continuously. On examination an indurated mass can be felt along the urethra, which bleeds on manipulation, and urethroscopy shows a typical malignant ulceration, usually extending all round the canal. The inguinal (inner) lymph nodes can be felt to be hard, fixed and matted, and often enlarged, especially if secondary infection be present. Later, periurethral abscesses and fistulæ will develop.

The *treatment* consists in implantation of radium needles or amputation of the penis and removal of the inguinal lymph nodes on both sides in all cases.

Paget's disease rarely occurs around the external meatus, where it shows as an excoriated weeping area, much resembling the appearance seen in the nipple and showing typical Paget's cells on microscopy.

Treatment consists in the use of X-ray therapy or the application of a plaque containing radium, and only if this line of treatment fails should the surgeon proceed to amputation.

STRICTURE OF THE URETHRA

When as a result of infection or inflammation in the urethra a patient for any reason cannot pass water, or the surgeon cannot pass a sound along the urethra to the bladder, such a patient is said to suffer from a urethral stricture. It will be understood that normally the urethral canal so called has its walls in apposition, and they separate, partly from pressure within and partly from muscular action, to allow the passage of urine or a sound. Stricture, therefore, will result if either muscle spasm, mucosal congestion or fibrosis in the urethral wall prevents this mechanism acting normally.

In any of these conditions where the patency of the urethral canal is interfered with by inability of the wall to dilate for the passage of the urine or an instrument, the stricture is spoken of as (1) congestive, (2) spasmodic, or (3) fibrous in nature.

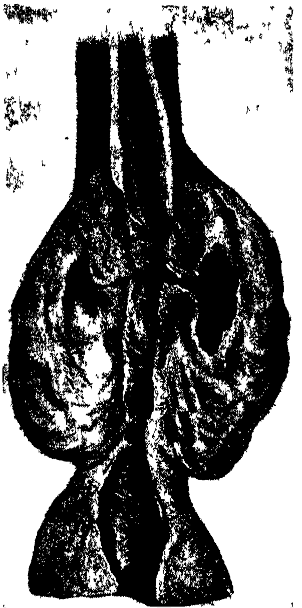


FIG. 301. Stricture of the membranous and spongy urethra, with periurethral abscess and fibrosis.

Frequently it must be realised that all three elements co-operate in producing "stricture," and indeed spasmodic and congestive strictures nearly always coexist.

Certain strictures are **congenital** (see p. 891).

(1) **Congestive stricture** is seen where acute infection is present in the urethra, and causes œdema in and around the epithelial lining. It is most common in acute gonorrhœa, but may follow sexual or alcoholic excess in chronic gonorrhœal subjects, especially if a fibrous stricture coexists. In itself congestion seldom causes stricture apart from spasm of the muscle in the urethral wall, which coexists as a result of the irritation. It is, however, important to remember that *in such acute infections no catheter should be*

passed for fear of conveying the infection to the posterior urethra and bladder. Rather, if retention be present, suprapubic aspiration of the bladder is to be preferred, if hot baths and sedatives fail to relieve it.

(2) **Spasmodic stricture** results from reflex spasm of the periurethral muscles, and is most marked in the region of the bulb and at the triangular ligament, where the compressor urethræ muscle surrounds the canal. It may result (*a*) from any inflammation in the urethra, and is then associated with a congestive stricture, as in gonorrhœa, calculus, and alcoholic excess combined with a fibrous stricture, etc.; (*b*) from irritation of the urethra by instrumentation; (*c*) as a reflex spasm due to peripheral irritation in the perineum and anal regions, as after pile operations, and occasionally as a complication of fissure-in-ano, especially in children; (*d*) as a result of irritation of the nerves of the cauda equina and pelvic plexus after injury; (*e*) in extreme fear or hysteria.

The retention is as a rule of a temporary nature, and if the patient is placed in a hot bath, and morphia and atropine injected, urine is usually voided; in more obstinate cases the administration of a hot enema or a brisk purge often will result in urination, and only in a few cases has resort to be had to a soft rubber catheter, which may have to be passed under local or nitrous oxide anæsthesia to secure cessation of the spasm.

In hysterical cases catheterisation should never be resorted to, as it encourages the patient, who always will pass water when really uncomfortable. No catheter must be used if acute gonorrhœa be present.

Most cases of *post-operative retention* are due to a spasmodic stricture, often combined with the recumbent position being awkward for micturition, and a certain amount of nervousness. Usually such patients will pass urine, especially if they can sit up, or be placed in a bath; but these aids are often not possible, and in such cases some additional stimulus, such as pituitrin, 1 c.c., urotropin, grs. x, or acid boracic, ʒi in ℥i of hot water, will produce the desired result. Should the bladder get very distended a soft catheter will have to be passed.

FIG. 302. Stricture in the penile urethra

(3) **Fibrous or organic stricture** is the result of cicatrisation in and around the urethra consequent on injury or post-inflammatory ulceration in the walls of that canal. The contraction of the scar tissue results in narrowing of the lumen of the urethra, which may become so constricted as markedly to impede or even prevent the urinary outflow. Naturally the changes will manifest themselves earliest in the narrowest part of the canal, *i.e.*, the urethra just at or anterior to the triangular ligament, so that it is here that organic stricture is most often seen; while, in addition, this is the most dependent point of the downward curve of the urethra, so that gonorrhœal discharges tend to collect here. Such cicatricial narrowing, however, may occur anywhere in the urethra, and although it practically never causes symptoms in the wide prostatic urethra, may give trouble in the narrower penile urethra, where multiple strictures not infrequently exist, the commonest penile situation being just within the meatus, behind the navicular fossa.

The Nature of a Stricture. According to the distribution of the fibrous tissue of the scar, various names are given to the type of stricture resulting.

Thus (*a*) an *annular stricture* is one where the scar tissue encircles the urethra ;

(*b*) A *bridle stricture* is one where a band is formed across the lumen, or only a portion of the circumference is contracted.

(*c*) A *ribbon stricture* is an annular stricture of some length, as if a ribbon had been tied around the urethra to constrict it, and the narrowed passage may be either straight or tortuous.

Other terms in use are *resilient*, which is employed to denote an elastic stricture which dilates readily on the passage of sounds, but immediately contracts on their withdrawal, and *cartilaginous*, or *indurated*, when the opposite is the case and the periurethral structures are much thickened and even cartilaginous.

There are two other groups of terms which are applied to strictures, and must be noted : A *passable stricture* is one through which a sound can be passed, while in an *impassable stricture* instrumentation is not possible. In this respect it should be noted that the number of impassable strictures met with by an experienced urethral surgeon is negligible.

A *permeable stricture* is one through which urine can be voided, even if only in drops, while an *impermeable stricture* means that no water can escape through it, a very rare condition except when of a temporary nature and due to superadded spasm and congestion,

It must be realised from the foregoing that a stricture may be impermeable and impassable, impermeable but passable, or more often permeable but impassable, and most often permeable and passable, distinctions which will be further referred to when the treatment of fibrous strictures is under discussion.

Causes of Fibrous Stricture of the Urethra. As already mentioned, fibrous stricture is always the result of scarring following epithelial destruction, which may be due to—

(1) *Trauma*, such **traumatic strictures** usually following rupture or contusion of the urethra, when they occur in the region of the triangular ligament; they also sometimes result from wounds. In either case they are usually long, tortuous, ribbon strictures, very hard, and very intractable ; more severe than the next group.

(2) **Post-inflammatory strictures** are far more common, and of these (*a*) gonorrhœal stricture is by far the most frequent, constituting over 90 per cent. of the organic strictures met with, (*b*) more rarely other forms of urethritis (B. coli, etc.) may give rise to stricture, while (*c*) cicatrisation of a urethral chancre, (*d*) ulceration from a calculus or foreign body, or (*e*) periurethral abscess are all infrequent causes. In addition, urethral or penile carcinoma may give rise to stricture, while contraction in operation scars also will lead to narrowing ; especially is this seen at the meatus following amputation of the penis. The distortion of the prostatic urethra consequent on enlargement of that organ (p. 920) will produce a mechanical obstruction to the outflow of urine, but not a fibrous stricture.

Secondary pathological changes occur in the urinary tract and vary in severity according to the tightness of the stricture and the time the lesion has been present.

(*a*) The *urethra* anterior to the stricture is normal in appearance, but that behind is much thickened and dilated, while in the stricture itself it is narrow, and the wall replaced by a mass of dense fibrous tissue. False passages, fistulæ and periurethral abscesses may be present at or around the region of the stricture (Fig. 301).

(*b*) The *bladder* is usually distended and shows more or less fasciculation of the musculature of its wall, while the mucosa is thickened and often desquamating or coated with mucus and phosphates as a result of the cystitis which is nearly always present in these cases. The urine is in consequence alkaline, phosphatic calculi may be present in the bladder or urethra, and there is frequency of micturition, due partly to the cystitis and partly to the distension of the bladder, which in neglected cases may pass to the stage of overflow incontinence (see p. 883). Often pus may be present in the urine.

(*c*) The *ureters and kidneys* become affected in old-standing cases, infection spreading either up the ureter, or in the lymphatics around it, so that pyelitis, nephritis, and renal abscess are by no means uncommon. The presence of pyelitis with multiple abscesses in the kidney (spoken of as " surgical kidney ") is often seen, and death occurs from uræmia in a number of these cases, amounting to about 5 per cent. of the total of urethral strictures.

Clinically the condition usually occurs between the ages of twenty-five and fifty-five, and is practically confined to males. The patient, who has generally had gonorrhœa some years previously, or may give a history of severe perineal trauma, will complain of increasing difficulty in micturition. He notices that straining is necessary to start and continue the act, and that in spite of all this effort the stream is small and comes slowly ; indeed, it may be little more than a slow drip in severe cases. Twisting or forking may be present, but is not to be relied on. There is often a gummy, mucopurulent discharge or a gleet. It will be found that there is considerable frequency, and that the condition is much aggravated by alcoholic or sexual excesses, or severe cold, so that retention is by no means uncommon after such indulgence or exposure.

If the patient is observed during micturition the stream will be seen to be poor, and the urine usually found to be alkaline. The patient always will strain to start the stream flowing, thereby showing the condition is due to organic stricture and not to prostatic enlargement, in which condition, owing to the distortion of the urethra (p. 920), straining retards the urinary outflow. The stricture is seldom palpable, but may be detected and located by the passage of a sound. For this purpose a fairly large instrument (Clutton $\frac{18}{20}$ to $\frac{18}{22}$) should be used ; after lubrication and introduction it is allowed to slide down by its own weight until the end is arrested on the anterior face of the stricture. A urethroscope can be passed and the stricture located and observed. The patient must be examined and investigated for signs of incipient uræmia, such as a dry, furred tongue, earthy skin, etc. (Chapter XX., p. 816). Occasionally the stricture can be felt in the penis or the perineum as a hard, tough, painless indurated swelling.

The *treatment* will depend on the type of stricture and its variety, and so will be discussed under the different clinical conditions which may be met with. It must be clearly remembered that on all occasions when instrumentation is used, the tip of the sound must be kept in the midline and undue violence avoided, or the sound will leave the urethra and pass into and lacerate surrounding tissues. These "*false passages,*" besides being a source of hæmorrhage and pain, are often the cause of extravasation of urine, periurethral cellulitis and abscess, or even of a urinary fistula.

Regular instrumentation after trauma or severe gonorrhœa is a valuable prophylactic against the formation of stricture of the urethra.

(A) **Permeable and passable stricture.** Uncomplicated stricture of the urethra should be treated by dilatation, so as gradually to stretch the fibrous tissue, which must be kept from recontracting by regular dilatation at frequent intervals.

(*a*) *Intermittent dilatation* is the best method and may be obtained either by the passage of graduated urethral sounds, by means of stretching with a urethral dilator, which can be expanded in the stricture, or by passing bougies through the stricture which is observed through a urethroscope.

Whichever method is adopted, and the first is that in most general use, no undue violence need be employed, and it is the aim of the surgeon to secure the fullest dilatation possible without rupturing the urethra and so causing hæmorrhage, the risk of periurethral infection and a severe inflammation which is productive of much scar tissue.

The routine to be followed in stricture cases is to pass the sounds twice weekly for six weeks and then once a week for six weeks. Thereafter, once a fortnight for three months, and once a month for the next six months. During the next year at first two-monthly and then three-monthly instrumentation is necessary, after which sounds should be passed six-monthly for another year.

It must be impressed on a stricture patient that it will take three years to ensure a cure, and that if he does not attend regularly and for the whole period, relapse of the condition is practically certain. Even after the three years it is wise to get the patient to attend once a year, or oftener should symptoms occur.

In attempting instrumentation it is always well to use a largish sound (Clutton $\frac{14}{18}$ or $\frac{16}{20}$), which will not catch its point in dilated crypts (as a finer instrument might), and thereby tend to increase spasm and cause false passages. When the sound impinges on the face of the stricture the point must be held in the midline and gentle and steady pressure be applied to the instrument, which usually passes through to the bladder, wherein it can be rotated freely. No hæmorrhage should occur or follow withdrawal, during which process the sound can be felt to be gripped in the stricture. Larger size sounds are then passed in gradation.

Should instrumentation fail under local anæsthesia, a general anæsthetic should be given, when relaxation of spasm of the periurethral muscles will occur and the passage of the instrument be facilitated. If, however, this fails, the sound is withdrawn and a smaller one tried, or numerous whalebone guides are passed down the urethra until one slips through the stricture into the bladder, when urine drips out. A railroad, or Goulet's catheter, or hollow sound is then passed along this guide through the stricture and usually left in situ (see Continuous dilatation). A better method if difficulty occurs is to pass a urethroscope and see the anterior face of the stricture, when an instrument (best a dilator) can be passed and the fibrous tissue be well stretched.

(*b*) *Continuous dilatation* consists in passing a sound or catheter through the stricture and leaving it in situ two or three days, when it will be found to be loose, and is then withdrawn and replaced by a larger instrument. This process is repeated until sufficient dilatation is secured, or may be supplemented by the rapid intermittent method. Continuous dilatation is not much used, as apart from the discomfort of the retained instrument, there is the very real risk of causing an acute purulent urethritis, with consequent periurethral abscess or fistulæ, or else new scar tissue with aggravation of the stricture. When, however, a stricture is very tight, and can be passed only with difficulty (see p. 905), then it is advisable to leave the catheter or bougie in situ for twenty-four hours, and proceed to pass sounds immediately on its withdrawal.

(c) *Cutting operations* may be employed, but are not often used in this type of stricture unless it is " resilient " in nature.

(1) **Internal urethrotomy** consists in passing an instrument containing a concealed knife blade, which is so graduated beforehand that, on pressing a handle, the knife edge is exposed to the required extent, and will cut into and divide the fibrous tissue around the stricture. The stricture may be stretched by a dilator combined with the urethrotome, or by the subsequent passage of sounds. Inasmuch as the periurethral tissues are laid open there is danger both of hæmorrhage and infection, which is greater than if dilatation with sounds is employed ; for this reason internal urethrotomy is not popular except when the stricture is resilient.

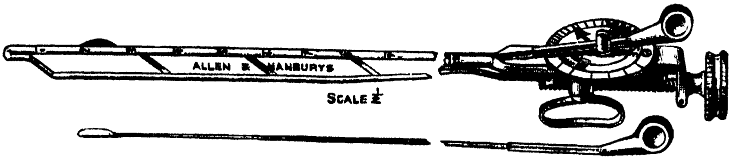


FIG. 303. Otis urethrotome.

Various types of internal urethrotomes are in use, some of which are made so that the knife cuts from behind forwards through the stricture as the instrument is withdrawn (Civiale's urethrotome), and others cut from before backwards as the instrument is introduced (Teevan's urethrotome), while in the " Otis " instrument the knife is concealed among the blades of an expanding dilator. None of them can be used unless a small bougie or guide can first be passed through the stricture.

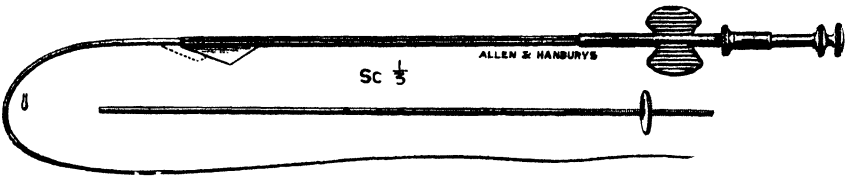


FIG. 304. Teevan's urethrotome with whalebone guide attached.

(2) **External urethrotomy** is an older operation, which is performed through the perineum, with the patient supported in the lithotomy position, the stricture being incised from without inwards down to the urethral lumen.

In a passable stricture *Syme's urethrotomy* is performed if the stricture is situated in the perineum, but does not give good results in penile strictures, where internal urethrotomy is preferable. A Syme's shouldered staff, like a curved sound with a groove along the lower (convex) border, and a narrowed extremity which connects with the broader staff by a definite shoulder, is passed so that the narrow portion enters and lies in the stricture, on the anterior face of which the shoulder rests. The shaved perineum is incised in the midline and the cut extended down into the

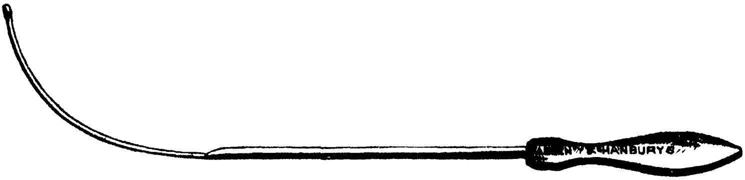


FIG. 305. Syme's shouldered staff.

groove of the staff, thus opening the stricture by cutting through the fibrous tissue on its perineal aspect. A large (No. 14) rubber catheter is then passed down the penis and guided through the divided stricture into the bladder and left there for several days, while the urethra and perineum granulate and slowly heal around it. Subsequently sounds must be passed regularly or else the stricture recurs in an aggravated form.

Wheelhouse's urethrotomy for impassable stricture is described under that heading.

(3) **Excision of the stricture** is the ideal operation and is carried out through a perineal incision as above, cutting down on a sound or staff to expose the anterior surface of the stricture. This is identified, dissected out, and removed. The ends of the urethra are then freed so that they can be approximated without tension and united by catgut sutures around a largish rubber catheter, which is left in situ for ten days.

This method gives excellent results with short strictures, but not with long ones, as too much tissue has to be removed to allow the urethral ends to be approximated ; for this reason it is of little use in the severe traumatic strictures where external urethrotomy yields better results.

(B) **Permeable but impassable stricture,** as already stated, is seldom met with, and then only as the result of inexperience on the part of the surgeon, who as the patient can pass urine will be wise when instrumentation fails, either to try again on a future occasion, or to call in the services of an experienced urethral surgeon. Should, even then, instrumentation fail, treatment on the lines of the impassable stricture with retention is indicated in so far as it deals with cure of the urethral condition. It must be remembered that many apparently impassable strictures will be passed easily under general anæsthesia as perineal spasm is thereby relaxed.

(C) **Impermeable but passable stricture** is commonly seen after Saturday night excesses, the unfortunate doctor being called up in the early hours of Sunday morning to relieve the patient's retention. The bladder will be distended and often palpable above the pubes, and the patient in severe pain.

There is in all these types of case superadded spasm and congestion, and if these be relieved by sedatives, hot baths and atropine, often the patient will pass urine, frequently in the hot bath.

Should these methods fail, a metal catheter, or better a hollow sound, should be passed through the stricture and the retention relieved ; here again anæsthesia by relaxing spasm will facilitate instrumentation. If the bladder is very distended and the stricture of old standing, it is advisable to empty the organ slowly, as sudden relief of pressure may be transmitted up to inefficient kidneys, and determine the onset of uræmia, which, as already stated, is responsible for death in 5 per cent. of stricture cases.

No time should be wasted in these cases in attempting to pass rubber or gum-elastic catheters, as these soft instruments buckle on the stricture, and merely cause an increase of spasm and congestion, which often renders a previously passable stricture impassable. A sound, with its lesser curve, is easier to pass than a silver catheter, and often slips through where the catheter fails ; for which reason the possession of a Clutton's $\frac{14}{18}$ sound bored down the centre to permit escape of urine often enables a surgeon to pass an instrument in these cases of retention when others have failed to do so.

(D) **Impassable and impermeable stricture** is a serious trouble, as the retention causes much superadded spasm, and so soon as it is clear that no instrument will pass under anæsthesia no time should be wasted in relieving the patient's retention by one of the means indicated below. Consequent on the relief of spasm the stricture is often passable if instrumentation be undertaken in about twenty-four hours' time, when the condition can be dealt with by one of the means indicated under (A). Should, however, instrumentation fail, then either the surgeon must perform (*a*) *external urethrotomy by Wheelhouse's method*, cutting down through the perineum, or (*b*) he must cut down as in this operation and then *excise the stricture* and suture the urethra around a rubber catheter, as described above.

Wheelhouse's external urethrotomy is employed in impassable stricture, Syme's operation being used in the passable variety. Wheelhouse's staff consists of a straight rod with a groove along one surface, and having the tip turned back to form a hook over the nongrooved surface. The patient being in the lithotomy position, and the perineum shaved and cleaned, a Wheelhouse staff is passed down to the stricture with the grooved surface toward the skin. The perineum and urethra are laid open on to the staff, which is then rotated through 180° and withdrawn so that the hook acts as a retractor to the anterior end of the cut urethra. The wound is dried, and the anterior surface of the stricture exposed and the opening sought in it; this is usually easily found and a probe or gorget thrust up into the bladder, when, if it is distended, urine will gush out. A catheter is passed through along this and left in for some days, when sounds are passed regularly to keep the passage open.

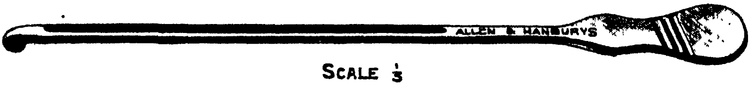


FIG. 306. Wheelhouse's staff.

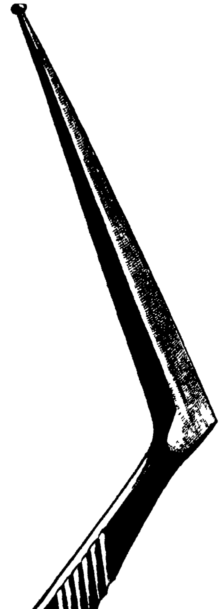


FIG. 307. Teale's probe-pointed gorget.

Relief of retention. When an impassable stricture is present, or if the presence of acute gonorrhœal urethritis renders catheterisation inadvisable, this may be achieved in any of the following ways :—

(*a*) *Suprapubic aspiration*, by means of a trocar and cannula thrust in through the midline just above the pubic symphysis, is very easily performed and quite safe so long as there is no cystitis. It is therefore suitable in cases of young subjects with spasmodic retention from gonorrhœa, but seldom advisable in organic strictures where the leakage of infected urine following withdrawal of the cannula is prone to result in abscess and cellulitis in the cave of Retzius and the abdominal parietes.

(*b*) *Suprapubic cystostomy* is therefore more suitable in cases of retention with impassable fibrous stricture, as the larger opening permits free drainage, and incidentally, should it be found impossible to relieve the stricture, will allow of the wearing of a suprapubic apparatus and portable urinal. Retrograde catheterisation also will be possible. The suprapubic opening will not heal until the stricture is relieved.

(*c*) *Cock's puncture;* this operation can be carried out rapidly under nitrous oxide anæsthesia, the patient being supported in the lithotomy position.

The gloved index finger of the left hand is passed into the rectum and its end rests on the distended urethra at the apex of the prostate. A scalpel or double-edged "Cock's knife" is then plunged in through the centre of the perineum, its point directed at the end of the left index finger; by doing this its point will enter the urethra and the urine gushes out. With the knife in situ a Watson's tube or catheter is passed into the bladder and secured there. This operation is usually easy, but should the prostatic urethra not be distended, may prove not only difficult but dangerous from hæmorrhage.

In all these operations the stricture needs treatment subsequently, or as soon as retention is relieved; it must be treated by one of the methods described, but if suprapubic cystostomy has been performed it may be possible to perform "retrograde instrumentation" from the bladder.

Diagnosis. Acute retention from adenoma or carcinoma of the prostate in elderly men may simulate that due to stricture, but in these cases there is often no history of gonorrhœa, the patient knows he can pass water easier if he does not strain, the prostate often will be felt enlarged on rectal examination and a bicoudé catheter will pass easily (Fig. 316).

It must be remembered that periurethral abscess and cellulitis often occur around strictures, especially after attempts at instrumentation where false passages have occurred. Urinary fistulæ are by no means uncommon in advanced cases, and may be present in large numbers, passing through a mass of fibrocartilaginous consistency, when they are very intractable and often call for a permanent suprapubic cystostomy.

In all cases treatment is on the lines laid down under these diseases, with the important addition that the stricture needs cure. Carcinoma is a by no means rare complication in old-standing and neglected strictures, especially if fistulæ and secondary infection be present.

For the causes of acute retention see p. 884.

INJURIES AND DISEASES OF THE PENIS AND PREPUCE

The penis is seldom damaged apart from the urethra, and injury to this has been dealt with on p. 894; owing to its great vascularity free hæmorrhage occurs, especially if the organ is damaged when in a state of erection. There are on record a few cases where the engorged penis has been bodily avulsed from the pubes. Occasionally the penis may be threaded through a ring or other aperture when the distal portion becomes swollen and gangrenous and often will require amputation, unless the ring is removed early (p. 912).

Congenital deformities occur with epi- and hypospadias where the organ is usually diminutive, and the resemblance to the female clitoris most marked in severe cases (p. 893). Rarely the penis is adherent to the scrotum, absent or bifid.

Phimosis is a congenital condition in which the prepuce is of undue length so that it projects beyond the glans penis, and in addition the orifice is often so narrow that the skin cannot be retracted. If the orifice is very narrow and the foreskin not tightly adherent to the glans, the redundant part will swell up like a bladder during micturition. In all cases the prepuce is abnormally adherent to the glans, and the white, cheesy smegma preputii accumulates in the sulcus behind the corona glandis.

If the condition is not treated, the child usually cries and strains at micturition, and the bladder-like distension may be noticed during the act. Occasionally, in severe cases, distension of the bladder and ureters, and even bilateral hydronephrosis, may occur. Owing to decomposition and infection of the retained smegma, balanitis (see p. 911) is not uncommon, and frequently recurs in older children where the constant irritation aggravates the phimosis and predisposes to masturbation. The irritation may be a cause of nocturnal enuresis, and in youths leads to sexual offences. The constant straining is said to predispose to hernia, and certainly forces contents into existing hernial sacs. In adults recurring balanitis leads to fibrosis and thickening of the prepuce and lining of the glans, so that cellulitis of the penis, and in later life carcinoma, are undoubtedly predisposed to, while should venereal disease be acquired the retention of discharges much aggravates the condition, and may lead to "phagedæna" (Vol. I., Ch. VII.).

The retained smegma in some cases becomes dried and calcified, forming "preputial calculi," such as are commonly seen retained behind the foreskin in Fijians. Such calculi may number ten or fifteen and vary in size from a millet seed to a bean, often being facetted. They may escape through the meatal orifice and be mistaken for a renal or urethral stone voided with the urine, and in other cases where balanitis supervenes may slough through the foreskin ; in many cases, however, they lie dormant for years.

Phimosis may be met with in adult life as an acquired deformity, when the foreskin may be short, but can no longer be retracted owing to inflammatory thickening or scarring. Such scarring may follow the healing of syphilitic or soft chancres, dirty habits, chronic eczema, or gonorrhœa, while it is occasionally seen in old men, often diabetics, as the result of chronic sepsis, in which case carcinoma often supervenes and may much aggravate the phimosis.

The *treatment* consists in circumcision, which should be carried out in infancy, when the condition is congenital, provided that the child is otherwise healthy. Stretching of the orifice with forceps to allow of retraction is recommended by some authorities, but gives poor results, as the foreskin is usually long and difficult to retract, so that cleansing away of smegma is hard to accomplish. Moreover, the narrowing of the orifice tends to recur.

Other surgeons believe that the condition improves as the boy grows older, and recommend leaving the operation till puberty, by which time bad habits often have been acquired.

Circumcision may be performed in a variety of ways, and the method will differ in the child and the adult.

(*a*) In children, where the prepuce and glans are adherent, the foreskin is pulled gently forwards and snipped off just beyond the glans penis. The inner lining remains adherent and is now slit down its dorsal aspect to just short of the corona, and stripped gently off the glans with gauze. Smegma is removed, and bleeding points in the foreskin, of which there are usually three, one at the frænum and one on each side, ligated. The inner lining of the foreskin is then turned down over the raw area and over the skin edge, and secured there by wrapping a gauze plug round the organ, no stitching being necessary. The operation can be done rapidly by this method, if necessary without anæsthesia, and gives excellent results. The plug is soaked off in a bath next day, and renewed then, and thereafter daily for a week or ten days, until the wound is healed.

(*b*) In adults, the foreskin is grasped on either side at its dorsal midline by forceps, and divided with scissors down to the corona, the skin being cut to a somewhat higher level than the inner lining. The foreskin is then cut away at the required level on either side and hæmostasis secured, thereafter the skin and inner lining are united with stitches of fine catgut. The wound is dressed with a plug soaked in sterile paraffin, which is changed daily till healing is complete. Bromides must be given freely, and should be commenced three days before operation, about twenty or thirty grains being given three times a day ; this is to prevent erections occurring, which cause great pain and may actually tear the stitches out.

Paraphimosis is a condition of semistrangulation of the inner lining of the prepuce of a patient with phimosis, who, having pulled the foreskin back, cannot return it because of the tightness of the orifice, which forms a ring-like constriction behind the glans.

The redundant and exposed inner lining nipped by this constriction becomes swollen and œdematous, and appears congested from obstruction to the blood flow, while the tightly stretched frænum often ulcerates and disappears. In severe cases œdema may show in the glans penis, and gangrene of the distal portion of the foreskin occur. There is often severe pain, and in adults persistent erection of the organ, which has a peculiar screw deformity.

Treatment. If left, the condition may subside; ulceration at the constriction ring causes adhesions, and a natural circumcision results, but it is not safe to rely on this and immediate reduction must be undertaken. The patient is laid on the bed and the penis grasped behind the constriction between the interlaced index and middle fingers of the two hands, while the thumbs are pressed on the glans and the foreskin dragged forwards. This procedure, especially in old-standing cases, causes much pain, which often has a salutary effect, but an anæsthetic may be administered. Should much œdema be present it will be much reduced, and subsequent reduction made possible by wrapping plugs, soaked in 1 per cent. cocaine and 1 in 1000 adrenalin, around the penis for half an hour, or the prepuce may be covered with stab punctures to allow escape of fluid. In very late cases an incision must be made through the ring on the dorsal surface to cut the constriction; then reduction will be simple.

After reduction it is wise to slit the dorsum of the prepuce and to complete the circumcision in about a week when the œdema has subsided.

Inflammations are usually confined to the glans (*balanitis*) or to the inner lining of the prepuce (*posthitis*) and the two conditions frequently coexist. Cellulitis may occur, especially if urinary extravasation is present, and calls for no special mention as regards diagnosis or treatment. Abscess may also occur or boils appear in the skin.

Paget's disease very rarely occurs in the glans penis (see p. 470). It is followed by carcinoma, and amputation is required if X-ray or radium therapy fails to effect a cure.

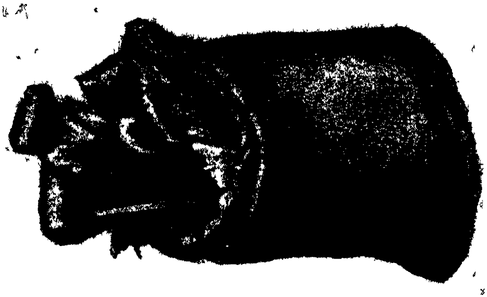


FIG. 308. Phagedæna. Note the skin of the penis remains separate from the body. The glans penis is entirely destroyed. (Rod in urethra.)

Herpes zoster may affect the prepuce, appearing as one or more raised red, painful and itching patches, which later vesicate in many places and may ulcerate. Herpes is often present on the skin of the penis, perineum or groins. The condition should not be mistaken for any other, though venereal sores have been diagnosed; but glandular enlargement is absent unless the lesions are septic, and the pain is usually severe.

Lichen planus may also occur on the prepuce, but other patches with their square-cut edges will be present on the skin elsewhere.

Balanitis may occur at any age and is always associated with phimosis or the presence of a long foreskin which is not retracted to cleanse the glans penis of the accumulated smegma beneath it. It is primarily due to irritation from decomposition of the retained smegma, which escapes as a thick discharge around the glans; this has a characteristic odour, and should not be mistaken for gonorrhœa. The condition is frequently accompanied by inflammation of the foreskin (*balanoposthitis*). Secondary infection is common, when the irritation becomes intense, the foreskin red and œdematous, lymphangitis and cellulitis of the penis being common complications, and enlargement and matting of the inguinal lymph nodes the rule. Where the foreskin can be retracted its inner lining is red and velvety and covered with shallow ulcers; these may be mistaken for soft sores, and they may perforate and cause the prepuce partly to slough, the glans projecting through the hole. In very severe cases, "Phagedæna" (Vol. I., Ch. VII.) may supervene. The condition in adults is usually associated with gonorrhœa, or the presence of a concealed syphilitic chancre, which may be palpable through the skin; it also occurs in diabetics and gouty subjects, apart from venereal disease.

Diagnosis is generally easy; the condition can be recognised at once from gonorrhœa by examining a film, though it must be remembered that the two conditions often coexist. In old men carcinoma around the corona glandis should be suspected if balanitis is present.

Treatment consists in slitting the prepuce down the dorsum to secure free drainage, and then bathing and washing it daily. When the inflammation has subsided the circumcision should be completed. Irrigation and packing under the prepuce are never satisfactory and, at best, only palliative.

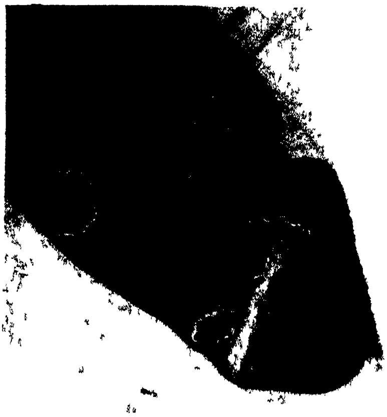


FIG. 309. Soft sores on the penis.

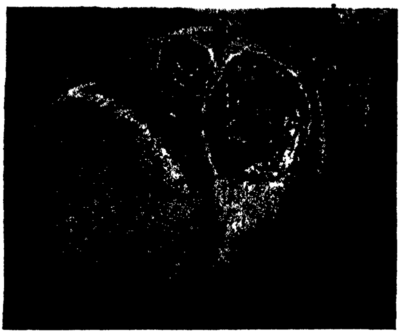


FIG. 310. Double syphilitic chancre.

Syphilitic and soft sores and gummata have been dealt with in Chapter VI., Vol. I.

Bilharziosis, seldom seen in England, is common among small boys in Egypt, and presents as a spongy bleeding mass of granulations, involving the glans penis and urethra. Sinus formation with urinary fistula is by no means uncommon. Vesical and rectal lesions often coexist and marked anæmia is present.

Treatment consists in administration of antimony salts, as laid down in Ch. VI., Vol. I., and gives good results.

Gangrene of the penis is rare, owing to the extreme vascularity of the organ; if it occurs, it usually affects the skin only and is of the moist variety. It is most often seen as the result of the penis being strangulated beyond a ring, through which it has been passed; we have seen a case of this description where the organ had been pushed through the hole in a heavy iron nut, weighing 4½ ozs., which had been worn five days on the gangrenous penis, the patient applying for treatment because micturition became impossible. Mothers have been known to tie a string round the penis of a child, to prevent it wetting its bed, so tightly that the organ has swollen and sloughed. On other occasions we have seen gangrene of the penis in individuals who have passed their organ through (*a*) a heavy hammer head weighing four pounds, and (*b*) their fiancée's engagement ring, both of which objects had become fixed on the gangrenous organ.

Gangrene also may follow unrelieved paraphimosis, septic ulceration (phagedæna), or infection of wounds of the organ, while it occasionally occurs in debilitated old men without apparent cause; more rarely it is seen after typhoid, and in young Jews, especially in South-East Europe, where it seems to occur from arteriole spasm, and to resemble in type the symmetrical gangrene of the lower extremities (Ch. VII., Vol. I.).

The *treatment* consists in amputation through healthy tissue.

Chordee is a painful condition in which, owing to thrombosis in one or other corpus cavernosum, or the corpus spongiosum, the penis assumes a lop-sided and distorted stance on erection. The organ, of course, will bend towards the lesion, where fibrosis prevents vascular engorgement. The condition usually follows a septic thrombosis and occurs as a sequel to severe gonorrhœa, but it may occur with stricture, periurethral abscess, and after septic wounds or severe contusions of the penis, which at the time of injury is swollen, tender and in a condition of semierection. Chordee, if severe, often wakes the patient at night and may prevent coitus, so that mental depression is often present. In old-standing cases the fibrous thickening is palpable.

Treatment consists in giving iodides and citrates by mouth, and local application of fomentations and gentle massage to re-establish circulation; bromides should be given at night. In old-standing cases, where fibrosis and thickening exists in the corpus cavernosum of one or both sides, external application of a radium plaque gives excellent and lasting results.

Priapism is a condition of painful and involuntary erection usually seen after injury to, or with tumours of, the spinal cord; it may follow excessive sexual excitement or masturbation in young males and is also seen in leukæmia. In many cases it is only an incomplete erection.

The *treatment* consists in giving bromides or other sedatives, and cold douching to the lumbar region and perineum. Rarely multiple small incisions into the organ may be necessary if other treatment fails.

Tumours of the penis are not very common.

(*a*) *Benign neoplasms* occur in the form of *papillomata*, which usually grow from the glans penis in elderly men and are very diffuse, being in many cases precursors of carcinoma, from which they can be diagnosed clinically only by the absence of any inguinal involvement.

Warts of a septic character, and with much evil-smelling purulent discharge, are commonly seen behind the corona in patients with a long foreskin and of uncleanly habits; they most often occur as a complication of gonorrhœa. Such are probably of infective origin, *i.e.*, granulomata, and not true neoplasms.

The *treatment* of papillomata in elderly men consists in excision, best carried out with the diathermy knife; should they be situated on the inner side of the foreskin, circumcision is indicated. X-rays and radium give good results in some cases.

Warts usually go if the region is regularly cleansed, but if extensive their disappearance can be accelerated by cauterisation with the diathermy apparatus, excision or X-rays.

Angiomata may rarely occur in connection with the corpus spongiosum, when severe attacks of urethral hæmorrhage often are seen. If the tumour involves the glans it presents the typical purple appearance of a cavernous nævus, while the same condition is seen on urethroscopy.

Treatment is difficult, but in one case laying open and diathermatising the penile urethra resulted in complete cure, no stricture resulting.

(*b*) *Malignant Neoplasms.* **Carcinoma of the penis** may start anywhere on the skin or in the urethra (p. 900), but most commonly it commences in the sulcus behind the corona glandis. The neoplasm is undoubtedly predisposed to by phimosis, dirty habits and recurrent balanitis, being most often seen in old men and hardly ever in people who have been circumcised. It is, of course, squamous-celled in type unless starting in Littré's follicles in the bulb, when it is columnar.

Clinically the disease nearly always starts at the reflection of the prepuce from the glans, though it may occur in the region of the frænum. Both glans and foreskin are invaded and become hard, while a sanious discharge escapes beneath the irretractable prepuce. The growth may commence as a wart or an indurated fissure, which can be felt through the foreskin; often considerable destruction of tissue has occurred before the patient seeks advice. The glands in one or both inguinal regions are hard, matted and fixed, while if sepsis be present, which it often is, they are enlarged and tender, and may suppurate. In advanced cases the whole penis is destroyed and the scrotum invaded.

The *diagnosis* is usually easy, for the patient is old and the induration of the ulcer marked. In phagedæna the skin of the penis is separate from the sloughing mass (Fig. 308), while in carcinoma it is infiltrated and incorporated in the edge of the ulcer (Fig. 311). In hard chancre the lymph nodes are much enlarged and discreet.

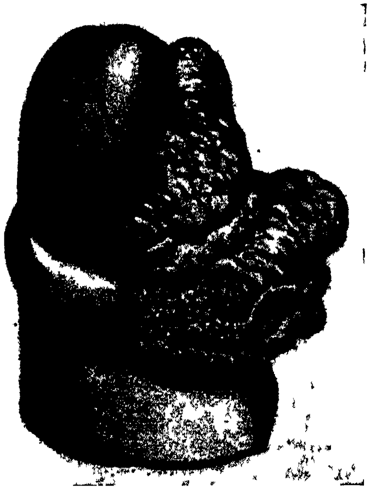


FIG. 311. Ulcerating squamous-celled carcinoma of penis.

The *treatment* consists in application of radium, which is often successful; should this fail, amputation of the penis must be performed an inch beyond the palpable margin of the growth and removal of the glands from both inguinal regions; if possible, the whole should be removed in one mass.

Amputation of the penis may be either (*a*) partial, (*b*) complete, and in the former case is a comparatively simple operation, while in the latter there is often much shock. Complete amputation means a perineal meatal opening, and should be combined with castration and removal of the scrotum, as this prevents fouling with urine.

(*a*) *Partial Amputation.* A rubber band having been fixed around the root of the penis to act as a tourniquet, the skin is divided by a circular incision, when it retracts about an inch. The corpus spongiosum is cut through at the same level as the skin, and the corpora cavernosa an inch higher up. Hæmostasis is secured and the tourniquet removed. The skin is then united, the corpus spongiosum being split for ½ inch, and the urethral edges united to the lower end of the skin incision; by this means danger of meatal stricture is avoided.

(*b*) *Complete amputation* is a serious operation, and only to be undertaken by an experienced surgeon. The patient is placed on the back and incisions made in either inguinal region as for hernia; through these the lymph nodes are dissected out, and the spermatic cords ligated and divided and the outer ends of the incisions are then sutured. The patient is now placed in the lithotomy position, and the incisions united across the penis and continued across the base of the scrotum into the perineum. The corpora cavernosa are exposed and dissected off the subpubic ramus, the penis, glands, testes and detached scrotum displaced towards the anus, and the corpus spongiosum cut across the bulb.

Hæmostasis is secured, the bulbar urethra split, and the edges sutured to the skin in the perineal wound, which is closed around the urethral orifice.

Thereafter the patient must sit to micturate, or be provided with a metal spout.

Cysts, both dermoid and sebaceous, may occur on the penis.

Dermoid cysts occur in the midline, usually on the dorsum and the skin can be moved over them. They seldom reach a size of more than a marble.

Sebaceous cysts may occur in any region and are fixed in the skin; often they ulcerate and the inspissated sebum and accumulated dirt form a "Sebaceous horn."

Parasitic cysts are rarely met with in this situation.

The *treatment* in all cases consists in excision.

DISEASES OF THE PROSTATE

Injuries of the prostate are very rare, apart from the laceration due to a false passage in instrumentation.

It must be remembered that, although the prostate is present as a rudimentary condition at birth and throughout childhood as a small gland around the urethra below the neck of the bladder, it does not develop and assume its adult form till after puberty. From this time to the age of twenty to thirty it increases steadily in size, and at this period, and not before, begins to be liable to the various diseases described.

Infections of the prostate are in the vast majority of cases due to infection of the gland from the urethra, though sometimes a blood-borne infection does occur, or disease spread to the gland by the lymphatics from the rectal or vesical mucosa. Inasmuch as nearly all cases of urethritis are gonorrhœal in origin, it follows that infection of the prostate is usually due to the diplococcus of Neisser, though occasionally other organisms, such as B. coli, staphylococci or streptococci, and in chronic cases B. tuberculosis, are met with in prostatic infections. The prostate is seldom, if ever, the seat of syphilitic disease.

The resulting inflammation may be (*a*) acute, or (*b*) chronic. As gonorrhœa is the common cause, the disease will be described as due to this, and a note made where differences exist when infection by other micro-organisms is present.

(*a*) **Acute prostatitis,** as already pointed out (Ch. VI., Vol. I.), is a common complication of gonorrhœa, usually occurring during the second or third week of the disease, and always resulting in cessation of the urethral discharge.

Clinically there is a sense of weight and discomfort in the perineum, which increases to agonising pain of an aching character as the inflammation progresses, and œdema and tension occur inside the dense prostatic capsule. In the early stages there is a constant desire to micturate, with strangury and hæmaturia in some cases, but later retention is common, and due to a congestive stricture. There is tenderness, and often œdema, in the perineum, and priapism may be present; the rectal sphincter is tightly contracted and rectal examination very painful. The examining finger finds the rectal mucosa hot and œdematous, and the prostate exquisitely tender. There is considerable general disturbance, with a raised temperature, foul tongue, and obstinate constipation.

Prostatic abscess often develops, when there is an exacerbation of both local and general signs and the onset of throbbing pain in the perineum; retention of urine invariably results if not already present. The rectal examination reveals softening and, maybe, fluctuation in the prostate, and the perineum may become red and swollen. If left the abscess will burst, usually into the urethra or bladder, when pus is voided in the urine and per urethram; more rarely the pus discharges through the perineum, or even into the rectum. This last is a serious complication, as secondary infection invariably occurs with, frequently, the formation of a recto-urethral fistula; it is, therefore, to be prevented by the early opening of the abscess in one of the other directions.

Treatment. In acute prostatitis this consists in rest in bed and frequent hot baths combined with the administration of sedatives and laxatives for the bowels. Rectal irrigation with hot water serves the triple purpose of relieving pain, producing prostatic hyperæmia, and promoting micturition and defæcation; it is, therefore, to be advocated, and may be carried out three or four times a day. Leeches may be applied to the perineum, and often give great relief.

Retention may be relieved by suprapubic aspiration or the passage of a rubber or metal catheter, if hot baths and sedatives do not produce the desired result.

When an abscess is present, as indicated by throbbing pain, it must be opened promptly in order to avoid any danger of its rupture into the rectum. This often may be encompassed by the passage of a metal sound or catheter, which evacuates the pus into the urethra, or by incision of the prostate through the urethroscope; in other cases it may be advisable to approach the gland through the perineum and drain the abscess by this route.

(*b*) **Chronic prostatitis** is one of the commonest causes of "gleet," and very often occurs as a complication of fibrous stricture of the urethra. The infection in the early stages is confined to the glandular crypts, which show epithelial proliferation and degeneration; the secretion, desquamating epithelium and micro-organisms are matted in the lumen, and ultimately are discharged into the urine as "*prostatic threads.*" Later the stroma of the gland becomes infected, and the gland can be felt to be hard, enlarged and nodular, often only one lobe being markedly affected; this stage in time passes to one of a small, uniformly hard, fibrotic prostate, due to contraction of the fibrous tissue consequent on the inflammatory reaction throughout the gland.

The disease may occur at any period of life, but is commoner after thirty, and frequently of insidious onset, there being no previous history of acute prostatitis during the attack of gonorrhœa.

Gleet is almost always present, and sometimes there is a very free mucinogenous discharge from the irritated prostatic epithelium, which may be so copious as to stain and stiffen the linen; in this case the term *prostatorrhœa* is often given to the condition.

The patient usually complains of a dull ache or a heavy feeling in the perineum, with pain referred along the penis. There is often frequency of micturition, and maybe hæmaturia at the end of the act, while there is a marked tendency to undue lasciviousness and priapism. In cases where much fibrosis is present in the gland, or marked urethral stricture exists, there may be considerable difficulty in micturition, especially in starting the act, while retention of urine is not uncommon.

Rectal examination will show the abnormal size and hardness of the gland, one lobe being often more affected than the other, but the median sulcus is always palpable.

Prostatic massage consists in gently expressing the gland follicles by stroking firmly on the organ with the finger in the rectum, and in these cases leads to the expression of the characteristic prostatic threads, which will be voided in the urine, and the presence of which is pathognomonic of chronic prostatitis.

General symptoms may be marked, especially in young adults, in whom prostatorrhœa is present; thus there is often asthenia and marked neurosis, with pains in the perineum and thighs; in these cases the prostate is often markedly enlarged, soft and tense, and massage may produce a teaspoonful or more of prostatic secretion.

The *treatment* consists primarily in treating the urethral infection and dealing with any stricture present, and in this relation it must be remembered that a very slight and otherwise unnoticed narrowing in the membranous urethra often will play an important rôle in keeping up prostatic infection. Regular prostatic massage, given daily for a week, and then weekly for a month or two, is of great value in relieving symptoms and clearing up the prostatic infection, especially in the early stages. In old-standing cases, where the gland is small, hard and fibrotic, massage is of little value.

A quiet life should be enjoined, with avoidance of alcohol and sexual excitement; open-air exercise is of benefit, but riding and cycling are contra-indicated, as the saddle congests the perineum and prostate. Large ($\frac{22}{26}$ Clutton) cold sounds should be passed in obstinate cases, and where a stricture is present often are of much benefit.

It is sometimes recommended to remove the small fibrosed gland, but this is very difficult, as there are dense adhesions to the capsule; where much obstruction exists to urinary outflow, a V-shaped area should be seared out from the posterior aspect of the urethral opening by the galvano-cautery; these cases are suitable for per-urethral surgery.

Tuberculous infection of the prostate is unfortunately fairly common in youths and young adults with urinary and genital infections. The B. tuberculosis usually infects the prostate from the bladder, and the vesiculæ and epididymes are generally also infected via the common ejaculatory ducts; rarely a blood-borne infection may occur, the disease starting in numerous foci in the substance of the prostate, and often being overlooked in the presence of the coexisting miliary tuberculosis. In the early stages typical giant-celled systems and miliary tubercles are present, and later caseation and abscess formation usually occur. Tuberculous cystitis, vesiculitis and epididymitis generally coexist.

Clinically a young adult who has noticed some frequency complains of pain on micturition, and perhaps hæmaturia, while there is a sense of deep-seated discomfort in the perineum, and sometimes rectal signs suggestive of irritation.

On rectal examination the prostate is hard, craggy and irregularly nodular, while areas of softening or actual fluctuation often may be detected in late cases. The vesiculæ may be felt to be similarly affected, and in young boys one or other ureter may be felt to be thickened or the base of the bladder indurated.

Chronic abscess of the prostate is usually tuberculous, it being very rare for suppuration to occur in other forms of chronic prostatic infection. The pus usually points into the urethra or bladder, and is voided with the urine, which is for the nonce full of small lymphocytes, débris, and tubercle bacilli.

The *treatment* consists in dealing with the urinary infection, though radical measures of a curative nature are seldom possible when prostatic disease manifests itself, as the disease is too far advanced. If one kidney alone is infected this should be removed, together with the ureter. Bladder ulcers may be diathermatised, and orchidectomy performed on one or both testes if necessary, the vasa and vesiculæ being removed (see p. 941).

It is seldom practicable or advisable to attempt removal of the prostate, but marked improvement, and even cure of the local disease, usually follows removal of the other foci in the genito-urinary tract.

Pulmonary and other foci of infection need consideration before any drastic surgical measures are undertaken in the genito-urinary tract. Tuberculin injections on the lines laid down in Ch. VI., Vol. I., are of great value in cases of prostatic tuberculosis, while cod-liver oil, open air and sunshine are not to be neglected.

Prostatic calculi, consisting of calcium salts, to which the mucinous gland secretion gives a glistening appearance, are by no means uncommonly met with in the crypts of a chronically inflamed prostate. Such stones vary in size from a millet seed to a haricot bean, and are often dark in colour and usually multiple. If confined to the gland they cause little or no symptoms, though they may be felt on rectal examination, and if very numerous grate on each other ; if, however, they ulcerate into the urethra they may cause obstruction to the urinary outflow or be passed in the urine. When in the urethra they may be heard to click on a metal sound, as it passes, or seen on urethroscopy.

The *diagnosis* is easy on rectal examination. If the stone is voided in the urine it may be mistaken for a renal calculus, but the prostatic stone is generally dark and shiny and composed mainly of calcium carbonate. A vesical stone of old standing may have a projection passing down through the sphincter into the prostatic urethra, this can be felt in the perineum and from the rectum ; it usually, however, causes dribbling incontinence, and so should not be mistaken for prostatic calculi, which lie below the vesical sphincter.

Treatment. If the stones are causing no symptoms they are best left undisturbed, but should they give rise to trouble they easily can be removed by the suprapubic route through the bladder. In most cases prostatectomy will be advisable.

PROSTATIC HYPERTROPHY AND ADENOMA OF THE PROSTATE

The enlargement of the prostate, which occurs normally during adult life, is of no surgical interest, as no symptoms arise therefrom ; its occurrence must, however, be remembered, as a rectal examination in an adult will reveal a rounded, soft, smooth prostate about the size of a chestnut or somewhat larger, with well-marked lateral sulci beyond its borders and a longitudinal median groove, easily palpable through the rectal mucosa, which moves freely over the gland. Such a prostatic enlargement is physiological, and unless any symptoms are present calls for no surgical procedure.

Very frequently, however, from about the age of fifty, and more often after fifty-five, though sometimes not until sixty-five to seventy years of age, a series of symptoms develop, which may be described as a "*prostatic syndrome.*" The mental condition of the patient often becomes altered, and he may become morose, or, if a quiet man, seek social amusement; there is usually more or less eroticism, often with abnormal sexual passions, so that indecent exposure or sexual assaults may occur. At the same time there is usually some urinary disturbance, which takes the form of increasing frequency and precipitancy of micturition, often associated with a tendency to erections, especially in the early mornings and the last half of the night, the whole being directly attributable to irritation in the prostatic urethra, probably due to leakage of a few drops of urine into it, following on the stiffening of the bladder neck and consequent failure of the internal sphincter muscle to function adequately. Often nocturnal frequency is first observed, but diurnal frequency generally coexists. Later, owing to the changes in the prostate described below, retention, with distension of the bladder and overflow-incontinence of a continual dribbling character, supervene; before this state is reached there is a period of increasing frequency, most noticeable towards the end of the night, so that after 2 or 3 a.m. the unfortunate man is urinating every few minutes, by reason of which his sleep is much disturbed and his mental condition thereby aggravated. Sudden retention or hæmaturia may be the first sign observed. In this stage infection of the urine with cystitis and pyelitis often occurs, which generally proves the last straw for the already overworked and often diseased kidneys, so that death usually supervenes from uræmia.

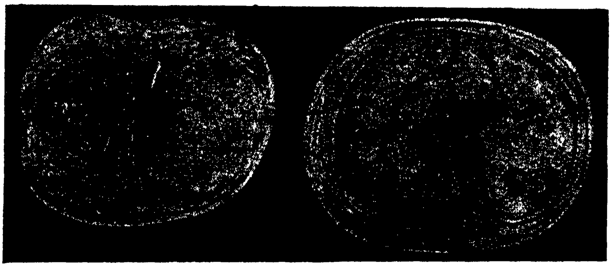


FIG. 312. Adenoma of the prostate, showing bilateral character of the tumour and prostatic tissue compressed around to make a "capsule."

These symptoms are invariably associated with changes in the prostate, which may take the form of either (1) the development of multiple fibroadenomata, the common type; or (2) dense fibrosis and contraction of the gland, which sometimes occur, often after chronic prostatitis; occasionally (3) carcinoma develops in the gland, usually in men below fifty-five, but sometimes supervening on old-standing fibroadenomata.

(1) **Fibroadenomata** usually develop after the age of fifty-five, and are most often seen between sixty and seventy years of age. They always develop in one or both lateral lobes, in the posterolateral part of the gland, and possibly arise in the submucous glands over the prostate and near the neck of the bladder (Albarran); the prostatic tissue thus becomes displaced and compressed, and forms a thin capsule around the adenoma and between

it and the true capsule of the gland with its contained venous plexus. It is from this false capsule that the adenomata are removed at " prostatectomy " in such cases, which explains the ease with which they shell out, and the fact that prostatic tissue and sexual power often remain, as the vasa efferentia, though distorted and compressed, usually do not pass through the tumour. Many patients will enquire as to whether their sexual powers will remain after the operation of prostatectomy, and they can be reassured that in the case of the adenomatous prostate, at any rate, there is a very good chance of their being preserved.

As the adenomata multiply and enlarge they will compress the urethra, and bulging most in the direction of least resistance, project up as a rounded mass into the floor of the bladder, where they form the so-called *middle lobe of the prostate.* This middle lobe, it is thus seen, is formed entirely of adenomatous neoplasm, arising from usually one, but sometimes both, of the normal lateral lobes of the gland, and therefore has no part in the anatomy of the physiological prostate. At the same time the neoplasm will press on the prostatic capsule laterally and project into (1) the urethra, (2) the rectum, and (3) also bulge towards the pelvic cellular tissue and levatores ani.

(1) *In the urethra,* owing to the fact that the adenomatous mass develops in the posterolateral part of the prostate, the anterior portion of which remains practically normal in size though compressed, the posterior wall alone will be appreciably elongated, though lateral compression and distortion of course occurs. Cuthbert Wallace has pointed out that this elongation of the posterior wall of the prostatic urethra, which is much exaggerated by the intravesical projection of the posteriorly situated middle lobe, results in the gentle curve of the urethra being converted into a right-angled bend as it passes through the gland (see Fig. 313). The result of this is that any straining to force the passage of urine, while dilating the upper limb, will close the lower limb of the urethra and produce obstruction to the urinary outflow, with retention; a simple mechanical explanation being thus afforded for the well-known clinical fact that a man with prostatic enlargement can micturate more easily, and often only, if he does not strain to commence the act.

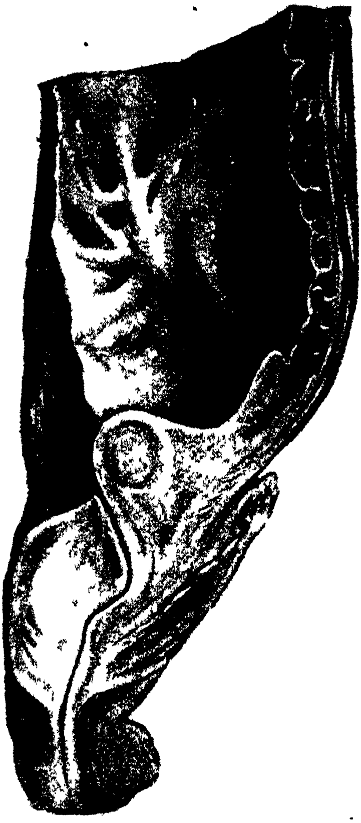


FIG. 313. Adenoma of the prostate. Note elongation of the posterior urethral wall and fasciculation of the bladder.

Occasionally retention may result from a pedunculated middle lobe being forced into the urethral orifice and acting as a " ball valve " ; such cases, however, are not often met with at operation.

As a result of this obstruction the bladder becomes much hypertrophied, and the muscle fibres stand out as "fasciculated bands," easily seen on cystoscopy, when also any upward projection of the gland can be detected. It is stated that in advanced cases dilatation of the ureters and hydronephrosis may occur, but if they do such changes are so rare as to be seldom met with, the spasm of the lower end of the ureter, which occurs normally when the bladder is distended, preventing the development of a back-pressure distension of this nature.

(2) *In the rectum* the gland can be felt projecting beneath the mucosa, which moves freely over it; it may be soft or moderately hard. The surface is generally smooth, but often harder areas and nodules can be detected by the examining finger, while the lateral sulci are more marked, and the median one persists, though it may be distorted.

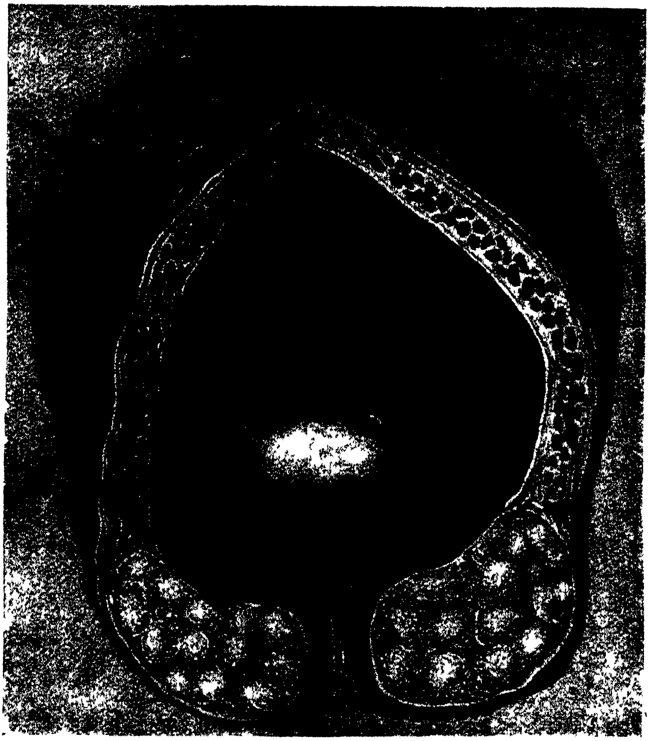


FIG. 314. The bladder opened anteriorly and everted to show the intravesical projection of the "middle lobe" of the prostate. The gland is the seat of multiple adenomata.

The absence of rectal projection, it must be remembered, does not preclude the presence of an adenoma, which, if small, may project up into the bladder only and give rise to marked urinary symptoms.

(3) *In the pelvic tissues* pressure may occur on the veins, so that hæmaturia and hæmorrhoids are common in such cases; but sciatic pain is never met with in simple fibroadenomata, only in carcinoma of the gland do nerves become involved. When the neoplasm is very large (and in old-standing cases it may reach the size of a small orange) the distortion of the levator ani and pressure on the rectum combined often result in loss of control and spurious diarrhœa, so that carcinoma of the rectum may be suspected, and

evacuation of mucus or fluid fæces will occur to a slight extent whenever micturition is attempted.

The adenomata are usually multiple, several occurring closely associated in an encapsulated mass, which shows, therefore, an irregular, nodulated surface, and on section presents rounded areas of denser tissue lying among a fibrous stroma. Such tumours are attached but loosely to the capsule except at one or two points, usually at the lower end, where the vessels enter. As already pointed out, the capsule consists mainly of displaced and compressed prostatic tissue, in which run the distorted vasa efferentia, the fascial gland capsule, with the prostatic venous capsule, lying external to the whole. These adenomata are always situated in the posterolateral aspect of the prostatic lobe and usually occur on both sides, though the mass on one side is generally the larger. They vary in size from a hazel nut to an orange, and in consistency from great softness to almost stony hardness, according to the amount of fibrous tissue present, so that carcinoma may be suspected. As already stated, they will expand most in the direction of least resistance, upwards into the bladder, and so produce the middle lobe, rectangled urethral deformity, and the various pressure symptoms previously described.

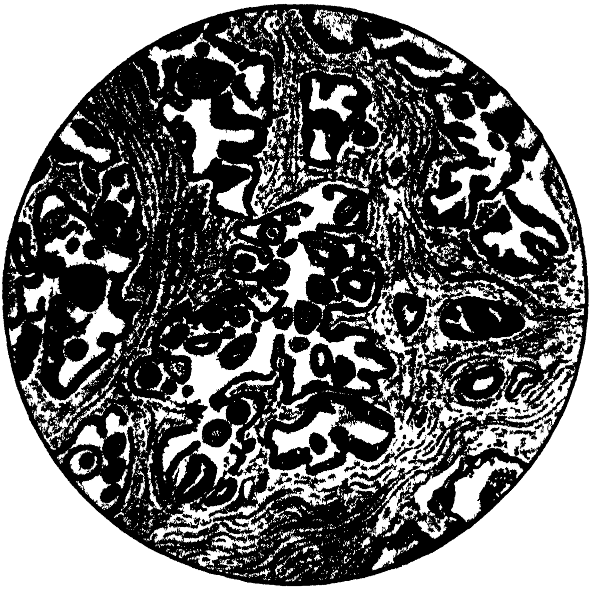


FIG. 315. Adenoma of prostate. × 35. Note granular bodies in gland acini (corpora amylacea).

Microscopically the section of such a tumour closely resembles the appearance seen in chronic mastitis, and unless it is known whence the specimen has come great difficulty may be experienced in diagnosis. Numerous distorted and flattened acinar spaces, lined with cuboidal and columnar epithelium, lie among a varying amount of fibrous tissue, often very dense and arranged concentrically around the glandular acini.

(2) **Fibrosis of the prostate** occurs usually in men of from fifty-five to sixty, but may be met with as early as soon after forty, especially in patients who have had chronic prostatitis following gonorrhœa. This variety of prostatic inflammation therefore is often associated with and aggravated by urethral

stricture (p. 901). The condition cannot be regarded in any sense as neoplastic, but is a fibrosis consequent on inflammation ; as would be expected, therefore, the whole prostate is affected, hard and often contracted, while the gland is densely adherent to the true fascial capsule. This condition sometimes occurs as a result of fibrosis after enucleation of an adenoma. This hard ridge-like fibrosis, sometimes spoken of as a "*Prostatic Bar*," definitely interferes with the relaxation of the internal sphincter and so greatly impedes micturition. Hence attempts at removal are attended with severe bleeding from tearing of the veins of the prostatic plexus, besides being often unsuccessful in removing the gland and not infrequently resulting in tearing open the pelvic cellular tissue and avulsion of the vesiculæ and even of the vas; this renders this type of case peculiarly suitable for some form of perurethral operation.

The urethra is not elongated, but generally compressed, and there is little, if any, intravesical projection.

On rectal examination the whole prostate is smooth and hard and often characteristically flattened, but the mucous membrane of the bowel moves freely over it, and the lateral sulci, though not so definite as usual, can be palpated. Calculi may be present. The gland may be smaller than normal.

Microscopically a section shows dense fibrosis, with little or no glandular tissue, while infiltration with leucocytes is frequent.

Carcinoma of the prostate is usually met with in men from fifty to fifty-five, and is of the spheroidal-celled type. The condition is discussed on p. 930; but it may be well to remind the reader that on rectal examination a hard and often nodular and craggy gland can be felt, while the bowel mucous membrane is early infiltrated and fixed to this, the lateral and median sulci are lost, and their places are taken by extensions of the growth into the pelvic fascial tissue. On these points and the patient's age a diagnosis usually can be made. Osseous metastases are common, and one of these may be the first sign before symptoms of prostatic disease are observed.

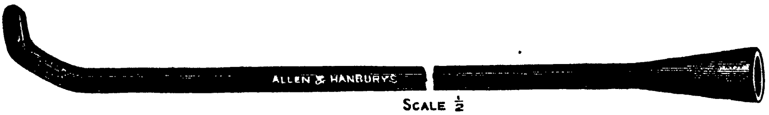


FIG. 316. Bicoudé catheter (gum elastic).

Clinically, an elderly man complaining of "prostatism," *i.e.*, the symptoms of the "prostatic syndrome" (p. 919), mental irritation, eroticism, and urinary frequency, is to be suspected of an enlarged prostate. In this respect it should be remembered that "lapses from grace" in elderly men of previously unimpeachable character are often attributable to this cause, and that the removal of the gland will ensure a cure of what is generally a source of worry and distress both to the patient and his friends.

On examination the lower abdomen is often seen to be distended, and should retention be present a pyriform swelling may be observed here. Palpation will reveal this to be due to a distended bladder, which is, of course, dull on percussion, and pressure on which will cause a desire to micturate. Bilateral direct inguinal herniæ (Chapter XIV., p. 580) are often present, due to the straining to pass water, and their presence in an elderly man always should raise a suspicion of prostatic enlargement, which needs treatment rather than the herniæ themselves.

It will be found that if after the patient has passed urine a catheter be passed, a varying amount of "residual urine" can be drawn off ; this may vary from ℥ss to Oij according to the severity and length of history of the prostatic trouble. Such urine in old-standing cases is often infected, and if B. proteus be present possesses that peculiarly offensive odour which often can be detected in public lavatories.

Rectal examination will reveal one of the conditions described, especial attention being paid to the consistence and limits of the prostatic tumour and the mobility of the rectal mucosa over this. As already noted, piles and spurious diarrhœa are often present. If retention of urine be present a catheter must be passed, and for this an instrument, specially long and anteriorly curved to allow of its passage through the angled and elongated prostatic urethra, has been designed. This is the gum-elastic bicoudé catheter, which *always* can be passed in adenomatous cases, though if it fails in the first attempt it should be bent further round, when the catheter will slip in. A special silver prostatic catheter is also made, and may be necessary in fibrotic and malignant prostates, while here also extra forward bending of the gum-elastic bicoudé instrument will nearly always permit of its passage.

Not infrequently hæmaturia may be present as a result of venous congestion; this, which usually occurs in attacks, may be very free. It is quite painless unless a carcinoma be present, and is more common in simple enlargement than in malignant disease. It is sometimes the first or only symptom.

The arteries and the tongue should be examined to ascertain their condition.

Cystoscopy may be practised with advantage, though difficulty often will be experienced in passing the instrument. The hypertrophied muscle fasciculi are very noticeable in the bladder wall, as also the spasm around the ureteric orifices. The shadow, or even the mass, of the intravesical projection can be seen around the internal meatus and its condition noted.

Diagnosis is usually easy if a proper examination is made.

(*a*) *Stricture* often gives rise to similar symptoms, especially if a fibrotic prostate coexists, but the onset of such symptoms in a man over fifty are generally prostatic, while in one under fifty they suggest stricture. Moreover, the man with a stricture always strains to commence urination, while he with prostatic adenoma awaits passively the commencement of the act. In most adenomatous cases there is no history of venereal disease or sexual excess.

(*b*) *Tabes dorsalis* may simulate the condition closely if vesical crises occur, but the other signs of the nervous derangement are present.

(*c*) *Chronic nephritis*, which often coexists, is a frequent source of hæmaturia, which, however, is often accompanied by mild renal colic, due to passage of clot down the ureter. In all such cases blood urea and urea concentration tests (Chapter XX.) should be carried out and the amount of residual urine be determined before any treatment is advised.

(*d*) *Carcinoma of the bladder* (or rectum if this has spread far) may give rise to frequency and hæmaturia, but pain is always present, and cystoscopy will clear up the diagnosis, as also in those rare cases when papilloma occurs in an old man.

(*e*) *Carcinoma of the prostate* (p. 930) may be diagnosed usually by careful examination and the younger age of the patient; but in some cases microscopy alone will differentiate it.

Treatment. The ideal treatment is to remove the obstruction and thus re-establish the urinary outflow. This usually can be carried out easily in the adenomata, which can be shelled readily from their capsule; but the conditions are far otherwise in the case of fibrotic and malignant prostates.

Removal of the gland, really of the adenoma, can be carried out either by the suprapubic or perineal route, the former being much more commonly used in this country, while in fibrotic prostates some form of perurethral prostatectomy can be used with advantage. Again, in many debilitated subjects partial removal by a perurethral operation subjects the patient to less risks than a suprapubic removal, and will suffice in all probability to enable him to micturate for the short span of life remaining to him.

Before attempting any operation for "prostatectomy" it is essential to examine the patient carefully, in order to ascertain if the kidney condition is sufficiently good to ensure that uræmia will not supervene. Careful attention must be paid to the length of history and to the condition of the patient's tongue, skin and arteries. If the tongue be moist and clean, the skin soft, and no undue arteriosclerosis present, the operation will be well tolerated, and in such cases the urine generally will be found to be nearly normal in content, the residual urine small in amount, and the history short. On the other hand, a dry, furred tongue, dry skin, and hard, tortuous vessels, with a long history, casts and albumen in the urine, and residual urine large in amount, usually contra-indicate radical operation in one stage, and even make the performance of a suprapubic cystostomy to relieve retention an operation of grave risk.

In addition, the various tests of "renal efficiency" (Chapter XX., p. 814), of which the most reliable is the blood urea content, and the next best the urine-urea concentration, must be carried out if possible. A blood urea of over 40–50 mg. per 100 c.c. contra-indicates immediate radical operation in one stage, as also does severe bladder infection.

Vasectomy. Some surgeons perform a preliminary vasectomy or vaso-ligation in order to prevent the ascending suppurative epididymo-orchitis which occurs as an immediate or remote result of prostatectomy in a certain proportion of cases. Should this occur after operation incision and often orchidectomy will be necessary. Others claim that prostatic atrophy and amelioration of symptoms follow this operation, while in addition increased sexual power results (Steinach).

Suprapubic prostatectomy is the operation most commonly practised in England, while the perineal route has more vogue on the Continent of Europe and the perurethral in America. The suprapubic route was first popularised by Freyer, and has since been modified by Thomson-Walker and Harris with a view to obtaining hæmostasis, so as to reduce the loss of blood following operation, to enable the bladder to be closed at operation and to prevent subsequent fibrosis at the operation site, and has the great advantage that it can be carried out in two stages if necessary, and this is often the case. Thus in those cases with a furred dry tongue, and a blood urea of over 40 mg. per 100 c.c., so often seen when retention is present, a suprapubic cystostomy can be performed by puncture under gas and oxygen anæsthesia, and a de Pesser's catheter inserted. Even this may prove too great a strain on the diseased kidneys, but in those cases where the patient survives, drainage for ten days to three weeks often will result in the blood urea falling below 40 mg. per 100 c.c. and the physical signs as regards tongue and skin improving correspondingly. In such circumstances the radical operation can be carried out when this improvement has occurred.

It cannot be impressed too strongly on the student that in all cases of suprapubic drainage, once the patient has got over the immediate effects of the operation he should be allowed up daily in a chair, the catheter draining through a rubber tube into a urine bottle. By this means the mental wandering and pulmonary complications, so often seen if these elderly people are kept in bed, can be avoided.

The one-stage operation for suprapubic prostatectomy is described here, but the surgeon will realise that often it is necessary to do it in two stages. (In a suprapubic drainage, when a subsequent prostatectomy is in view, the incision should be placed as high as possible, as the second operation can then be conducted below the first incision, and the danger of opening the adherent peritoneum much lessened and usually avoided thereby.)

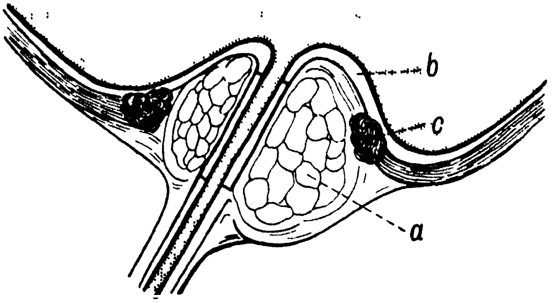


Fig. 317. Adenoma of prostate in situ. *a*, Adenoma. *b*, Mucous membrane *c*, Internal sphincter.

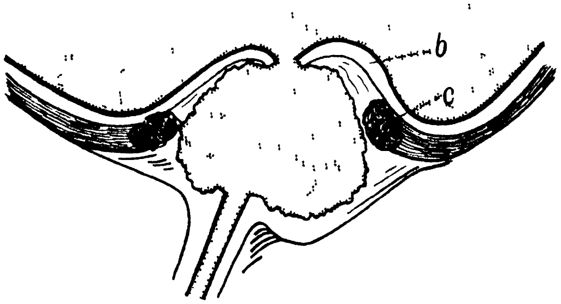


Fig. 318. Adenoma enucleated.

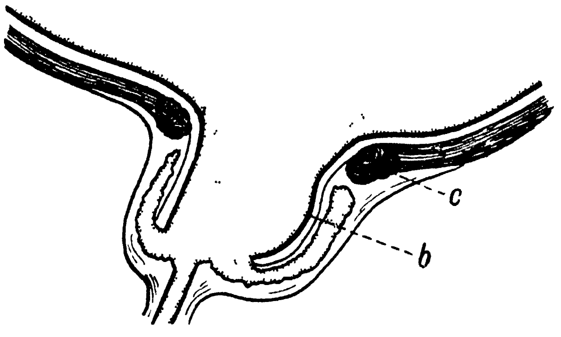


Fig. 319. Mucosa fallen into the cavity.

The pubes having been shaved and cleansed, the table is slightly tilted down towards the foot end, so as to facilitate free passage of fluid from beneath the patient, whose legs are separated, the feet being supported on a board, so as to keep them dry. A "Hamilton-Irving" suprapubic box should be fitted to the patient prior to operation if (as is our practice) it is intended to use one afterwards.

General anæsthesia with ether is preferable to gas and oxygen, as the deeper anæsthesia lessens shock and gives better muscle relaxation. Some surgeons advocate spinal anæsthesia in these cases, but it has no advantage over open ether.

The surgeon (unless able to use his left hand) usually stands on the left of the patient, as his right hand is then available for enucleation of the gland.

A catheter is passed and the bladder distended, unless it is already full of urine; the catheter is then withdrawn. A suprapubic incision is then made, either vertical or horizontal, just above the pubes and to the left of the midline, the left rectus is exposed and retracted outwards, the transversalis fascia opened and the peritoneum displaced upwards from the distended bladder. This is incised in the midline, in an avascular area, there being no need to secure the viscus to the abdominal wall before opening it. A finger is then inserted and the prostate palpated and identified. The left index finger is inserted into the rectum and the gland elevated and steadied by this throughout the operation of enucleation, which is usually carried out by the right hand, the index and middle fingers of which are inserted into the bladder. The index finger is passed into the prostatic urethra, and the mucosa scratched or cut through, together with the underlying tumour capsule; the finger is now worked around the adenoma, which generally can be enucleated rapidly and easily. The adenomata from the two lobes may come out separately. On removal of the mass the rectal finger is withdrawn and the glove changed on the left hand; a catheter is passed into the prostatic cavity through the urethra and irrigation freely carried out with hot saline (125° to 130° F.), when the internal sphincter and levator prostati muscles will be felt to contract up and nearly obliterate the cavity from which the neoplasm has been shelled out; at the same time, partly from this muscle contracture and partly from the heat, hæmorrhage is arrested. Massaging the prostatic cavity will also assist to stop the bleeding. This practice will obviate the necessity for either putting the patient up in the Trendelenburg position, opening the bladder widely, inserting a light and pulling up and exposing the prostatic bed to arrest hæmorrhage, as advocated by Thomson-Walker, a proceeding attended often by considerable shock, or the insertion of a Pilcher's rubber bag with a like object, a practice likely to result in sepsis, with its attendant danger of secondary hæmorrhage. While the irrigation is continued a *very large rubber drainage tube* is inserted, down to the pouch, and the muscle and fascial planes closed around it. The very large tube is necessary to allow blood clot to escape: if necessary, the prostatic cavity can be packed down it if bleeding subsequently occurs. The skin is sutured and the Hamilton-Irving box applied. Irrigation is now stopped. The tube can be withdrawn in forty-eight hours, or sooner if extruded; the Hamilton-Irving should be worn till free urination occurs per urethram, in usually from ten days to three weeks; the patient can be allowed up in a chair at the end of ten days.

Harris has used a further modification which not only secures fairly adequate hæmostasis, but also fastens the posterior mucosa down into the prostatic cavity, thus re-establishing the mucous lining of the urethra and preventing the possibility of the formation of a prostatic bar subsequent to the operation. In addition, it allows the bladder to be closed and drained through a catheter inserted via the urethra, which saves the patient a long convalescence, together with the discomfort of wearing a suprapubic box.

It must be realised, however, that hæmostasis is not always perfect, and a certain proportion of these cases have to have the bladder re-opened a few hours after operation to allow removal of clot, and that in these cases a suprapubic box must be worn and no shortening of post-operative convalescence must be anticipated.

In our opinion bladder washing per urethram after the operation is best avoided unless the urine becomes very foul, the urinary passages being flushed from above by diuresis, induced by administration of gin and copious hot drinks, while a mixture such as :—

℞	Hexamin	aa grs. x
	Ac. Sodii. Phosph.	
	Inf. Buchu ad	℥i six-hourly,

may be given for ten days or a fortnight; after which, if any mixture is necessary, the following should be substituted, in order to avoid renal irritation from the hexamine:

℞	Pot. Cit.	grs. xxx to ʒi
	Tinct. Hyoscyami	♏x
	Inf. Buchu ad	℥i t.d.s.

Many surgeons use regular daily bladder washing with some mild antiseptic solution. It can then be done up the urethra without a catheter by means of a Higginson's syringe.

Perineal prostatectomy is seldom practised; the patient is placed in the lithotomy position and a transverse incision made in the perineum just in front of the anus. The rectum is now separated from the prostate, and this must be carried out very cautiously as the bowel is very liable to be opened; should this accident occur the rent must be sutured, the wound drained and the operation abandoned. The urethra is opened and a Young's expanding prostatectomy retractor passed up and opened, so as to pull the prostate into the wound. The exposed lower end of the urethra is then cut through, the adenoma enucleated with the finger or a dissector, and Wildbolz's suture of the cut urethral ends is carried out, as this is a distinct advance on Young's original method where drainage was carried out through the perineum and the urethra left to granulate around a catheter. A modification of this method, as practised by some surgeons, gives a far better exposure of the prostate, and consists in approaching the gland laterally through a large incision opening up the ischiorectal fossa.

Perurethral Prostatectomy. In America and in this country, modifications of Young's punch—with which in some cases a diathermy cautery is incorporated—have been used for the removal of portions of the prostate through the urethra. Indeed, some surgeons claim that the entire prostate can be removed by this method, but such claims must be entertained with considerable doubt.

The bladder having been distended with sterile fluid, a continuous stream is maintained through the prostatome so as to keep the prostatic urethra dilated, and under direct vision slices of the prostate are removed; these being subsequently washed out from the bladder, if necessary.

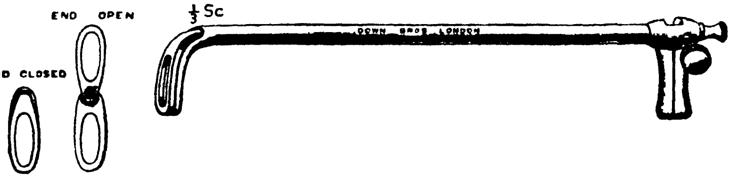


FIG. 320. Young's prostate retractor.

Diathermy is used to secure hæmostasis, and the bladder is subsequently irrigated. This method is particularly suitable for fibrous prostates, the removal of prostatic bars and for securing the passage of urine in cases where the patient is too feeble to stand suprapubic prostatectomy. We do not advocate it in cases where large adenomata occur in a healthy individual, as these can be more satisfactorily and adequately removed by the suprapubic or perineal routes.

A troublesome complication often seen after any form of prostatectomy (within two or three weeks) is an epididymo-orchitis. To prevent this some surgeons make a practice of tying both vasa deferentia at the time of the operation.

Sequelæ. After prostatectomy by either route it may be found that fibrosis and scarring in the cavity prevent the natural passage of urine, and so keep open the suprapubic wound if this be present. In most cases the regular passage of urethral sounds will effect a rapid cure, and should be practised in all cases where urine is not passed naturally in a fortnight after prostatectomy. Should this fail, however, a further operation will be necessary to excise the fibrous diaphragm formed by the scar tissue. Occasionally a fibrous diaphragm of this kind may appear months after the operation and give rise to retention.

Fibrous Prostatitis. As already discussed, when considering the tough fibrotic prostate, where obstruction to the outflow is usually the chief symptom, enucleation is not only often impossible, but frequently dangerous and even fatal, from the severe hæmorrhage which ensues consequent on tearing of the veins of the prostatic plexus. In these post-inflammatory cases, therefore, where the whole gland is adherent to the true capsule, enucleation should not be attempted, and some other means must be resorted to for the relief of the urinary symptoms.

In view of the frequent coexistence of a fibrous urethral stricture, some means of dilating this, and incidentally the narrowed prostatic urethra, such as the passage of sounds, often will give considerable relief. The improvement, however, is usually only temporary, and some method must be employed for the removal of at least a portion of the prostate and the establishment of a normal urinary outflow.

Various operations have been designed, the principal of which is the excision of a wedge-shaped portion of the prostate on the posterior aspect of the urethra, the wedge having its base towards the bladder. This is best carried out by the diathermy or galvano-cautery through a posterior urethroscope or cystoscope (*perurethral prostatectomy,* see above), but may be accomplished by use of the knife, punch, forceps or scissors through a suprapubic cystotomy wound. In the latter case it is essential to obtain a good view of the operation area. Great and usually permanent relief follows operations of this type, though sounds will be required regularly to keep open the channel in the prostate and the coexisting urethral stricture.

After operations, at times, difficulty of micturition is caused by a fibrous " diaphragm " ; here the regular passage of sounds or a perurethral division usually effects a cure.

Such operations as castration and ligature of the vasa deferentia, which used to be practised, have nothing to recommend them.

There remain a number of cases where physical signs, high blood urea or other conditions contra-indicate any operative procedures, and others in which, after a preliminary suprapubic drainage, the blood urea remains persistently high, showing that chronic nephritis is present and absolutely contra-indicating removal of the obstructing prostate. In such cases it is not usually wise or justifiable to perform perurethral prostatectomy, which is often fatal unless cases are selected as carefully as for removal of the gland.

In the former case resort must be had to regular catheterisation to relieve the urinary retention and frequency. Bicoudé gum-elastic catheters should be used, and the patient will have to be taught to use them himself. The importance of asepsis in the passage of the instrument and the necessity of carrying it in an antiseptic solution in a portable catheter case must be impressed on the patient, who, however, seldom heeds the advice given. As a result many old gentlemen early in " catheter life " get cystitis, and often suppurative epididymo-orchitis (p. 938), as a result of catheters being carried loose in the hat or pocket, and passed after lubrication with unsterile vaseline, or even saliva ! Patients seldom survive more than eighteen months or two years from the commencement of a " catheter life," unless their circumstances and intelligence are very good.

The second type of case, where a suprapubic cystostomy exists, is best met by the fitting of a permanent suprapubic apparatus. This consists of a metal tube, which passes through the wound into the bladder, fitted into an abdominal belt, and draining into a rubber bag worn on the inner side of the thigh inside the trouser. Two such apparatuses should be purchased and worn on alternate days, that not in use being boiled for twenty minutes and carefully dried to prevent any infection or uriniferous odour. A similar apparatus is also worn in carcinoma of the prostate and impassable and impermeable urethral stricture which cannot be relieved.

CARCINOMA OF THE PROSTATE

Carcinoma of the prostate is usually met with in men from fifty to fifty-five years of age, but may occur earlier ; it will be seen that the malignant disease occurs in younger patients than does adenoma. The neoplasm is usually spheroidal-celled and contains much fibrous tissue, being analogous to scirrhous carcinoma of the breast, which it closely resembles on microscopic section. Occasionally the tumour is of the columnar-celled type, when it is not so fibrotic, but disseminates and spreads much less widely.

Metastases are fairly common and usually occur in the bones, especially those of the pelvis and lumbar vertebræ and more rarely of the skull and the clavicle ; it is of interest to note that metastases from a prostatic carcinoma may cause a dense formation of new bone, being thus unlike most secondary carcinomata, where new bone formation is conspicuous by its absence (Chapters VIII. and XVIII., Vol. I.).

The growth extends locally into the bladder and urethra, where it ulcerates and causes hæmaturia ; into the rectum, where ulceration may occur ; and into the pelvic cellular tissue, where involvement of veins causes piles, and infiltration of the pelvic nerves gives rise to sciatic pain, which is often bilateral. In late cases constriction of the iliac veins may give rise to a characteristic œdema of the perineum and inner side of the thighs.

Occasionally malignant changes supervene in adenomatous tumours in old men, when growth becomes more rapid and symptoms increase ; in such cases enucleation is difficult, as the growth invades the capsule.

In cases of fibrotic prostate carcinoma not infrequently supervenes, its onset being indicated by the development of sciatic pain and hæmaturia, while the gland enlarges rapidly and invades the surrounding pelvic tissues.

Clinically the signs of the " prostatic syndrome " (p. 919) are often absent, while urinary obstruction develops and progresses rapidly, and usually occurs in a younger man. In addition, there is later persistent pain in the perineum and back of the thighs and legs, due to involvement of the sciatic nerves ; hæmaturia is sometimes present, and is then constant. Retention of urine is often an early sign, while nocturnal frequency seldom develops.

Rectal examination shows the gland to be hard, nodular and craggy, and perhaps ulcerating, while the rectal mucosa is fixed to it and does not slide over the prostate under the examining finger. Moreover, the gland is not confined to the normal limits of its capsule, and the carcinoma can be felt extending into the pelvic tissue both up behind the bladder and laterally, so that the median and lateral sulci are obliterated.

In late cases œdema may be present on the inner side of the thighs and lymph nodes be felt along the aorta, but this is seldom possible. Metastases in the bones may be the first sign of the prostatic disease.

The manifestations of the disease may be roughly divided into three groups : (1) the latent type, where the presence of carcinoma is found only on removal of the prostate. Here the prognosis is fairly good ; (2) the invasive type, which rapidly invades the pelvic fascia and gives rise to pain down the legs ; (3) the metastatic type, with early secondaries in the bones, especially the femur and vertebræ.

Treatment is of little avail, and death usually ensues in about a year or eighteen months. Deep X-ray therapy offers the best hope of cure, while in cases with difficulty in micturition a perurethral resection will permit the act, though as it divides the gland capsule the carcinoma often increases rapidly and soon reblocks the urethra. In early cases enucleation of the gland may be attempted, but seldom removes the disease; Young practises excision of the entire gland with the base of the bladder, vesiculæ and pelvic glands, a severe and often fatal operation. Radium may be inserted into the prostatic urethra by means of a catheter, or into the gland in the form of needles, but is of doubtful value, although it eases pain and sometimes effects improvement temporarily—it allows the growth to escape into the surrounding tissues.

In most cases a permanent suprapubic cystostomy offers the best relief and allows the escape of urine. It should be performed so soon as urinary symptoms become marked.

The *diagnosis* is usually easy, but in the early stages confusion may exist with adenomata, and more especially fibrotic prostate, in both of which conditions, however, rectal examination shows the enlargement to be limited by the normal gland capsule.

Carcinoma of the rectum may be simulated.

In conclusion, it should be remembered that in any man over forty the onset of sciatica, especially if bilateral, or the appearance of nodules on the skull, clavicle or other bones calls for rectal examination with a view to ascertaining the condition of the prostate, and also to determine that no rectal neoplasm is present.

INJURIES OF THE TESTIS, EPIDIDYMIS, SCROTUM, TUNICA VAGINALIS, SPERMATIC CORD AND VESICULA SEMINALIS

Injuries of the testis and epididymis are, owing to their somewhat exposed position in the scrotum, by no means uncommon, and are always productive of sickening pain, vomiting and great shock.

Contusions usually occur during athletic games, but may be the result of deliberate assault, when the organs may be so crushed as to be disorganised and need removal. There may be œdema, bruising or actual laceration of the scrotum, while the affected organ is usually swollen and exquisitely tender, and effusion may be present into the tunica vaginalis (p. 951).

Treatment consists in rest and the application of evaporating lotion to the scrotum, while the damaged organs should be supported in a suspensory bandage. In severe cases morphia may be given for pain and shock, while if the gland is much disorganised excision may be necessary.

Wounds of the testis may result in war, from self-mutilation or attempted castration. The injured organ may be projecting through a scrotal wound, or may have been ablated; if the tunica albuginea has been incised, a large mass of disrupted tubules is usually fungating through the incision.

Should sepsis supervene in these cases, *fungus* or *hernia testis* results, when a mass of suppurating, gangrenous and sloughing granulation tissue and disorganised tubules projects through the hole in the tunica albuginea. In crushing and gunshot wounds the gland is often disorganised, and much shock is present.

Treatment consists in cleansing the gland, clipping away protruding tubules, and closing the wound in the tunica albuginea. The testis is then replaced in the tunica vaginalis, and this and the scrotum are closed around it after excision of the edges of the wounds; drainage is often advisable for the first twenty-four hours. Where the gland is disorganised or sepsis and hernia testis have supervened orchidectomy should be practised.

Orchidectomy and Castration are the operations for the removal of one or both testes respectively. The former operation is practised to remove a disorganised or diseased gland, while the latter, though extensively practised in the East to provide eunuchs in the harems, is seldom carried out in Europe and America. Castration, however, may be sought by choir boys to prevent the voice "breaking," and is also sometimes necessary in bilateral testicular disease, usually tuberculous.

The operation is simple; the pubes having been cleansed and the patient anæsthetised, an incision is made over the external abdominal ring and the spermatic cord identified. This is then freed and the testis and surrounding tunica vaginalis drawn up from the scrotum by traction on it; the cord is then ligatured firmly in two places and divided between these. In tuberculous cases the incision is carried up through the inguinal canal, and the cord traced up to the internal ring where the vessels are ligated; the vas is then traced to the vesicula seminalis, which can be also removed if it be diseased. The wound is closed with a series of sutures or Michel's clips.

Where a scrotal wound exists, the testis can be removed through this if so desired, great care being taken to ligature the cord securely.

The **scrotum** may be incised or lacerated in any injury to its contents, but also may be damaged when these are left intact. In either case, so far as the scrotum is concerned, treatment must be carried out on the lines laid down in Ch. IV., Vol. I.

Contusion of the scrotum results in extensive bruising and swelling of that organ owing to the laxity of the connective tissue deep to the dartos muscle.

Owing to their protected position the vesiculæ seminales are seldom, if ever, injured.

The spermatic cord may be damaged in stab wounds of the groin, or occasionally at operations for hernia, when an incised wound results. Hæmorrhage from the pampiniform plexus is very free, and calls for open operation to secure and ligature the cut veins, which may have retracted to a considerable distance from the wound.

Thromboangiitis obliterans has been described in the vessels of the spermatic cord (see Vol. I., Ch. X.). It may closely resemble a tuberculous epididymis.

Subcutaneous rupture (*hæmatocele of the cord*) may occur as the result of kicks and blows, and again hæmorrhage is free, and tends to gravitate into the scrotum from the inguinal canal. The whole cord presents as a thickened globular mass, which at operation is of a deep plum colour.

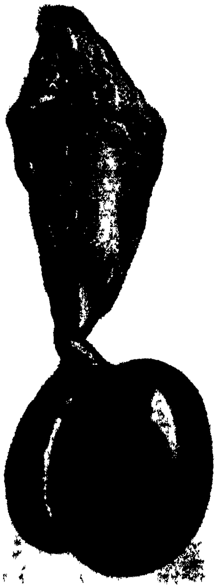


FIG. 321. Torsion of the spermatic cord.

Treatment consists in operation to secure the bleeding vessels. Occasionally a thrombosed vein may occur as a hard tender cord in the scrotal portion of the cord, and in this case no treatment is called for unless infection and suppuration supervene, when incision will be necessary.

The **vas deferens** may be torn rarely or cut from wounds or violence, but is more often severed during the careless cleaning of a hernial sac at operation. Suture may be performed, but it is very doubtful if the duct is ever re-established, and if the testicle becomes swollen and painful at or after coitus, orchidectomy will be necessary. In most cases, however, no untoward results occur, and certainly in the cases we have observed no atrophy of the gland resulted.

Torsion of the testis, or more correctly speaking "torsion of the spermatic cord," usually seen in boys and adolescents, may be the result of catching the testis on the thigh in a sudden turning movement, but often no such history can be elicited. The condition is more common in undescended testes where a long and lax lower end of the cord exists inside the tunica vaginalis, and a marked mesorchium permits of rotation of the testicle ; in the fully descended organ the twist sometimes occurs entirely inside the tunica vaginalis. One, two or more rotations of the gland on the cord will result usually from right to left, so that the circulation is impeded and the whole testis and epididymis become swollen and a rich purple in colour (resembling a plum), while if the condition is unrelieved gangrene will ensue. There is usually a blood-stained effusion into the tunica vaginalis, the distended condition of which, especially if the testis is in the inguinal canal, often leads to the incorrect diagnosis of strangulated hernia. In other cases it is only the hydatids of Morgagni which undergo the torsion.

Clinically, in the vast majority of cases the onset is definite and sudden, with intense pain, nausea and vomiting, which coincide with the appearance of a tense, tender swelling in the region of the testis, which sometimes can be felt to be rotated with the epididymis lying anteriorly. Frequently slight fever may be present. The attacks may subside spontaneously, but often recur, and ultimately gangrene of testis, with loss of pain, will occur following a severe attack, when unless operation be undertaken promptly peritonitis is likely to follow the sloughing of the undescended organ. If only the hydatid is twisted, the painful swelling is confined to the top of the testis.

Diagnosis is by no means easy, as *acute orchitis* closely simulates this condition, and in both fever will be present, but usually the youthful age of the patient and the absence of signs of urethral infection will clear up the question. Infarct or thrombosis of the spermatic cord will closely resemble the condition.

Strangulated hernia is closely simulated if the testis be in the inguinal canal, but here the absence of fever, the absence of the testis from its normal place in the scrotum and the signs of acute obstruction should establish the diagnosis.

A testis in Scarpa's triangle, if strangulated, may simulate closely an *acute inguinal adenitis*, while if retroperitoneal there may be marked abdominal rigidity with tenderness and vomiting, so that *pelvic peritonitis* (which may be present in these cases) or even *intestinal obstruction* may be suspected.

Treatment. This consists in operation to expose the testicle by opening the tunica vaginalis, when the plum-coloured organ is revealed. If the case is early the cord may be untwisted and the testis stitched to the tunica to prevent recurrence, but if late and gangrene threatens, orchidectomy must be carried out.

A congenital hernia, if present, should be cured.

The **tunica vaginalis** may be contused or wounded with the scrotal contents, but is most often damaged when tapping a hydrocele. In such cases hæmorrhage occurs from the veins, and a *hæmatocele* results, presenting as an oval, opaque, fluctuant swelling lying around the front and sides of the testicle which cannot be palpated. The condition is fully discussed on p. 955.

Treatment in the early stage consists of rest and a suspensory bandage with withdrawal of blood by "tapping," if this does not absorb in a week. In old-standing cases orchidectomy and removal of the mass is called for. If suppuration occurs prompt incision and drainage are necessary to preserve the testicle.

CONGENITAL ABNORMALITIES OF THE TESTIS AND PROCESSUS VAGINALIS

Very few authenticated cases have been recorded either of absence of one or both testes, nor of the presence of an accessory organ.

Development. It will be remembered that each testis is developed from the genital ridge, lying to the inner side of the Wolffian body in the retroperitoneal tissues of the dorsilumbar region. This mesodermal mass is invaded by islets of cœlomic epithelial tissue from which the seminiferous tubules are subsequently developed; these tubules ultimately connect with the Wolffian duct, from which the vas and vesiculæ develop, through some of the Wolffian tubules which form the epididymis. About the fifth month of fœtal life the testicular mass begins to descend behind the peritoneal cavity towards the scrotum, which it reaches about the ninth month of intrauterine life, pulling down with it as a tubular process (processus vaginalis) the peritoneum attached to its anterior and lateral surfaces. This " descent of the testicle " is brought about by means of the gubernaculum testis, a band of fibrous tissue containing some unstriped muscle fibres, which is attached at its upper end to the lower pole of the testis and the adjacent peritoneum. The lower end is attached normally to the bottom of the scrotal pouch (external genital ridge), but it may get displaced into the perineum, crural canal, or between the layers of the abdominal wall after emerging from the external abdominal ring and the testis may be drawn into one of these abnormal positions (*misplaced testis*). If the tunica around this and also the process in the scrotum become the seat of fluid effusion, a *bilocular hydrocele* results.

Further, the gubernaculum gains attachment to the front of the sacroiliac joint, the internal abdominal ring and the pubic spine, so that the descending testicle may be arrested at any of these points (*undescended testis*).

In any of these cases there will be a peritoneal sac drawn down around the testis, so that a congenital hernia (Chapter XIV., p. 581), often interstitial in type, is a common complication of these testicular malpositions; moreover, a second sac may be drawn down to the scrotum or elsewhere by an extra attachment of the upper end of the gubernaculum, when a " hernia-en-bis sac " results (Chapter XIV., p. 588).

The *processus vaginalis* is normally obliterated except in its lowest part, where it persists as the *tunica vaginalis* around the testis, but it may remain patent throughout its entire length, when a *vaginal congenital hernia* results, or in its upper part, the tunica vaginalis being shut off, when a *funicular congenital hernia* is formed (see p. 582).

Should the sac be obliterated above and the tunica vaginalis be shut off below, an *encysted hydrocele of the cord* results if the cyst is unilocular, and a *diffuse hydrocele of the cord* if there are multiple small cysts. This latter condition is also sometimes met with along the course of the spermatic vessels behind the peritoneal cavity.

Normally the testis reaches the pelvic brim about the fifth month, the inguinal canal during the seventh month, and the scrotum at the ninth month of intrauterine life. These facts are sometimes of value from a medicolegal standpoint in establishing the age and possible viability of male children at post-mortem examination. It must further be remembered that in childhood the power of drawing the testes up into the inguinal canal persists, as in the lower mammals.

Undescended and Misplaced Testis. These two conditions can be discussed together from a clinical standpoint, though as already pointed out above their developmental origin is not the same.

(*a*) A **misplaced testis** is usually situated in the perineum, but may occur in Scarpa's triangle just at the exit of the crural canal, or lie in the abdominal parietes between the external oblique aponeurosis and Scarpa's fascia, when it is easily palpable. The scrotum on the affected side is usually moderately formed, and not infrequently contains a pouch of peritoneum into which a hernia may descend; should a hernial sac, as is often the case, also exist around the misplaced organ a hernia-en-bis sac occurs. The scrotal hernia is often mistaken for a testis, and the patient considered to possess three such organs.

(*b*) An **undescended testis** is commoner than a misplaced one, and in a small percentage of cases the condition may be bilateral. The testis may be situated retroperitoneally in the region of the sacroiliac joint, but more commonly lies in or just outside the inguinal canal, in which situations it is readily palpable. A word of warning is necessary in regard to diagnosing undescended testis (or testes) in small boys, for firstly it must be remembered that in premature babies the testes will not be descended at birth, nor for a month or two afterwards, and secondly, small boys when cold or frightened often will retract the testes up into the inguinal canals and so simulate double undescended testes. This power exists up to the age of approximately seven years.

As with misplaced testes, congenital hernia is a common accompaniment of the undescended testicle, but hernia-en-bis sac is rarely met with in this condition.

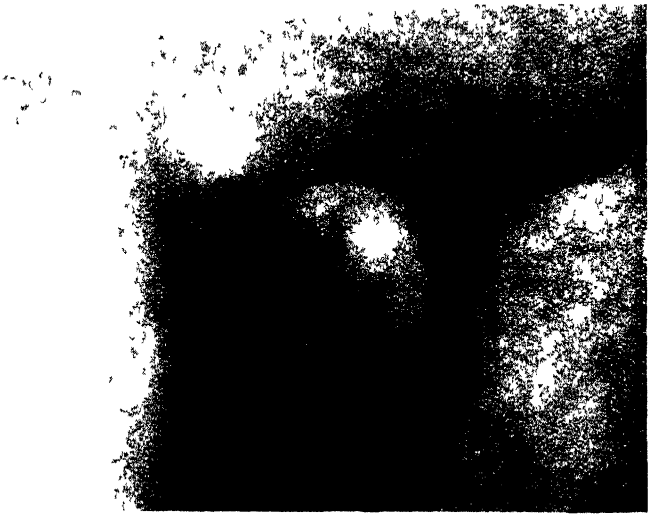


FIG. 322. Perineal misplacement of right testis.

Severe epi- and hypospadias are always accompanied by non-descent of the testes (pp. 892, 894).

Pathology. In both conditions, and more especially in non-descent, the testis is usually poorly developed both in size and glandular elements, while the epididymis is generally long and loosely attached by an elongated mesorchium. On section the gland is seen to be firmer and whiter than the normal testis, and on microscopic examination the ducts are found to be occupied by solid masses of polyhedral cells, showing little or no signs of active spermatogenesis ; the cells giving rise to the internal secretion are, however, normal in appearance, though surrounded by more fibrous connective tissue than is the case in the normal gland. It has been stated that such testes are more liable to be the seat of malignant neoplasms, but there seems little evidence in support of this assertion, though it must be admitted that the abnormal situation of such glands renders the early recognition of the tumour more difficult should it occur. They are certainly more liable to injury if lying over the pubic spine.

Clinically the boy is usually small, undersized, for his age, and not well developed sexually, especially when the condition is bilateral. Puberty is late and sexual desire seldom marked, though such cases, even with double undescended testes, are capable of parenthood—usually for a short period, from about twenty to thirty years of age. These signs are not so marked in cases of misplacement, where sexual development may be normal. On examining the local region the scrotum will be seen empty and ill-developed on the side of the lesion, or almost absent in bilateral cases. This sign may not be obvious if a hernia be present in the scrotum.

An ovoid swelling, varying in size with the age of the patients, but roughly corresponding to that of the other testis, may be detected in the perineum, abdominal wall or Scarpa's triangle in misplaced organs, and in or just below the inguinal canal in undescended testes.

Palpation will show this to be a testicle, and gentle pressure elicits the typical sickening sensation, though not to so marked an extent as in a normal organ. Coughing generally demonstrates the coexistence of a hernia, which may indeed mask the testicular swelling, while occasionally a hydrocele may be present around the viscus and will, of course, be translucent. It must be remembered that a long mesorchium usually exists, so that the epididymis appears as a separate organ in many cases, and moreover that torsion of the viscus is particularly liable to occur in these cases.

Diagnosis usually presents no difficulty if a careful examination be made. Rough handling or a cold room may cause a child to retract the testes and so simulate bilateral non-descent, while a scar following removal of one or both organs may escape notice.

Treatment. As a general rule no treatment should be undertaken until after the tenth year or, better, the sixteenth, as the testis often descends at this period or even later. In undescended testis it is justifiable to give injections of "*pregnyl,*" or other preparations containing adrenal and pituitary hormone, and these are often successful in procuring descent; parents must be warned that undue development of the external genitalia and sexual precocity may result from the injection. Should this fail, and always in malplaced testis or where hernia is present, operation is called for. If possible the organ should be exposed, freed and placed in the scrotum, where a bed must be prepared for its reception, but often this may be impracticable, as the cord is frequently too short to allow it to reach the scrotum or to lie there without tension. In order to combat this many surgeons divide all fibrous tissue and the pampiniform plexus, and even separate the epididymis from all but the upper extremity of the organ, so as to enable it to lie in the scrotum; such measures are justifiable in candidates for the public services, where absence of a testis from the scrotum is a bar to admission. Much help can be obtained in drawing the testis down if the cord is short by mobilising the peritoneum and spermatic vessels on the posterior wall of the abdomen as far up as possible. *Torek's operation* consists in implanting the testis, drawn through an incision in the scrotal wall, into a bed prepared for it in the subcutaneous tissue of the same thigh; after some three months this is freed and replaced in the scrotum, both which and the cord have been stretched by the patient's movements. Other surgeons stitch the organ through the scrotum to the opposite thigh, or to a metal suspension frame (Watson Cheyne), or pass it through a slit in the septum to the opposite side of the scrotum (P. Turner), but when the stitches are withdrawn the testis often retracts up and lies over the pubic spine, where it is very liable to injury, and becomes a source of pain and annoyance. Moreover, after such severe handling the gland usually fibroses, atrophies and becomes functionless.

If, therefore, the gland cannot be replaced in the scrotum without tension and a severe operation, it is better either to fix it in the retroperitoneal tissue near the internal abdominal ring by means of a catgut suture, or to remove it. Inasmuch as abdominal reposition leaves the gland with its internal and often external secretion, and as the greater frequency of malignancy in such testes does not appear to be established we are in favour of this procedure.

In those cases where a hernia coexists, the sac of this must be cut across and dissected from the cord, and its neck transfixed and ligated, before the testis is dealt with.

Congenital hydroceles are discussed on p. 951.

DISEASES OF THE TESTIS AND EPIDIDYMIS

The testis, epididymis, vas, and tunica vaginalis are so intimately associated both in their functions and anatomically, that any disease of one of these organs will affect the others to a greater or less extent. In the subjoined account of the affections of these viscera, where the conditions will be discussed in relation to individual organs, and signs and symptoms indicated as applying to each, it must be understood clearly that pathological changes of a similar nature will generally coexist in neighbouring tissues, where they will give rise to appropriate clinical manifestations.

Acute infections of the testis and epididymis may occur (1) rarely as the result of infection of wounds involving the tunica albuginea, and in such cases the infection is usually pyogenic.

Clinically the testis becomes swollen and tender, and granulations and pus exude along the track of the wound, while in many cases these develop into a definite hernia testis. A hydrocele, hæmatocele or pyocele will develop in the tunica vaginalis and may mask the testicular condition. The whole testis may become infiltrated with numerous abscesses, or may slough, forming a necrotic mass, in which case the wound and surrounding scrotal integument are often gangrenous. There will be usually engorgement and tenderness of the cord, in the course of which abscesses may develop.

The general signs are often marked, there being high fever, malaise and constipation, while vomiting and even rigors are not uncommon.

Diagnosis should present no difficulty in these cases if acute traumatic orchitis be excluded on the history.

The *treatment* consists in freely laying open the wound track, and, if a hernia testis be present, the tunica albuginea, so as to allow free drainage. Should sloughing occur, or the testicle be much disorganised, orchidectomy should be performed through an enlargement of the scrotal wound, a drain being left in situ for forty-eight hours. As it is doubtful if the gland ever functions after a severe infection no hesitation need be felt in performing orchidectomy in these cases.

(2) More rarely still a pyæmic abscess may occur in the testis or epididymis, when the organ will become swollen and tender, and a fluctuant hydrocele form around it. If the abscess is in the posterior part of the gland fluctuation and redness may be detected behind the hydrocele. There is marked constitutional disturbance, and probably other abscesses will be present.

(3) In *mumps* a blood-borne infection not infrequently occurs, which, however, never goes on to suppuration. Usually about ten days after the appearance of the salivary glandular swelling, one or both testes become painful and swollen. On examination the testes can be felt enlarged, hard and tender in the majority of cases, but in others, especially in youths, there is generalised

enlargement and tenderness of the entire epididymis, the testes being apparently normal. In either case there will be a small and usually lax hydrocele. Atrophy of the testes may follow.

The *diagnosis* is easy if the salivary swellings are still present or a careful history is taken ; otherwise tuberculosis or gonorrhœal epididymitis may be suspected. Acute traumatic orchitis can be excluded when no definite history of injury is forthcoming.

The *treatment* consists of rest in bed for a few days and the use of some form of suspender. It must be remembered that the patient is often sterile but not impotent after such an infection.

Gouty orchitis of a similar nature occurs in elderly men, coinciding with the joint attacks.

(4) *Infections via the vas deferens from the urethra* are by far the most common cause of an **acute epididymo-orchitis** and, as might be expected from the route of the infection, the stress of the resultant inflammation is most evident in the epididymis, though in the later period the body of the testis also is involved. For the same reasons the earliest signs of infection are nearly always seen in the globus minor at the lower pole of the testis ; rarely an abscess may occur in the spermatic cord. Two types of this descending epididymo-orchitis are commonly met with.

(*a*) **Pyogenic,** which occurs in septic urethritis in cases of stricture, prostatic infection, B. coli and staphylococcal urethritis, and after prostatectomy. Such cases therefore are more common in elderly men, and always go on to suppuration, thus frequently involving the loss of the affected testis.

(*b*) **Gonococcal,** which occurs in acute and less often in chronic gonorrhœal urethritis, usually about ten days after the onset of the initial infection. These cases seldom suppurate, and are most frequent in young men, though no age is exempt.

Clinically both varieties present many features in common. A cessation of the urethral discharge almost invariably coincides with the onset of the epididymal infection, and persists throughout the course of the scrotal complication.

The patient experiences a sense of discomfort and dragging in the scrotum, which rapidly passes to acute pain, worse on standing or walking, and often accompanied by vomiting. Fever, anæmia, malaise and constipation are usually present.

Examination, which is very painful and resented, reveals a tender swollen epididymis, the swelling in the early stages being in the lower part (globus minor) ; later the whole organ and the testis itself become enlarged and tender, and a hydrocele, which is usually small and lax, develops. The cord is often engorged and tender, and abscesses may develop in its course.

In cases where suppuration supervenes the lower part of the scrotum usually becomes red and œdematous, and the testicle fixed in this situation, in which fluctuation ultimately develops. It is a noteworthy fact that, if left, the pus generally points behind through the skin and seldom bursts into the tunica vaginalis.

In neglected cases the whole scrotum may become markedly œdematous and even gangrenous, while in pyogenic infections the testicle often sloughs and discharges piecemeal through a scrotal sinus.

The *diagnosis* is usually easy, especially if the reddened appearance of the meatus be noted and the urethra is examined as to the state of its lumen (except in acute urethritis), and smears examined in all cases. Rarely epididymo-orchitis due to mumps may simulate this condition, but the acute tenderness is never present, and the history is characteristic, while the usually youthful age of the patient helps to disarm suspicion. Sudden onset of epididymitis, with a hydrocele in small boys, sometimes occurs in tuberculosis, but the condition is seldom painful or really tender. Gouty orchitis may give rise to error in old men, but should not be diagnosed unless a joint is also affected.

Treatment. In all cases the urethral condition needs careful attention, especially in gonorrhœa (Ch. VI., Vol. I.) or stricture (p. 903). The scrotum and its contents must be supported in a suspender and rest in bed enjoined till the acute stage has passed. If suppuration supervenes, early incision of the abscess, from the back if possible, should be undertaken for the relief of the agonising pain ; should the gland become much disorganised, orchidectomy may be undertaken promptly, as such glands will be sure ultimately to require removal.

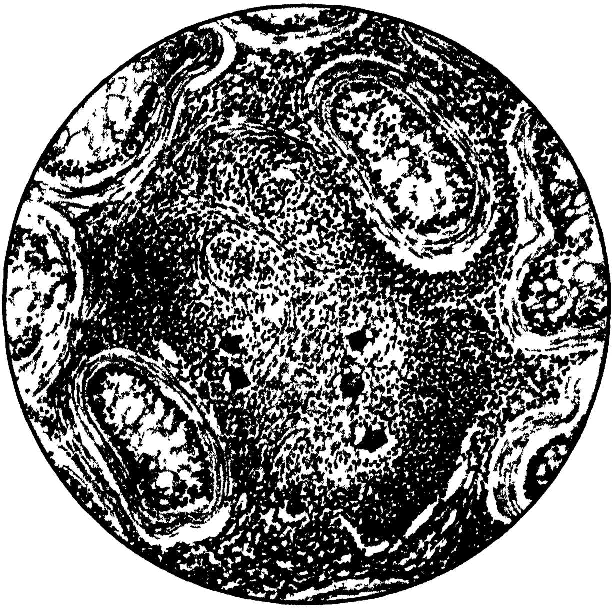


FIG. 323. Tuberculosis of the testis. × 55.

It is very doubtful if testes which have been infected ever function again, and many cases of sterility in the male are due undoubtedly to fibrosis and obliteration of the epididymal tubules consequent on previous gonorrhœal epididymo-orchitis.

Should abscesses develop along the cord they must be incised and drained. Cultures from these and from epididymal abscesses usually yield a pure growth of the causative organism and always should be taken in case vaccines may be required.

Recurrent or subacute epididymo-orchitis may occur in any of the foregoing conditions, and is also seen in both gummatous and secondary syphilitic affections.

Chronic epididymo-orchitis is nearly always either (1) tuberculous or (2) syphilitic in origin, other causes being due to infection in elderly men with enlarged prostate and usually due to B. coli.

(1) **Tuberculous Epididymo-orchitis.** Infection with the B. tuberculosis may be blood-borne, but is nearly always secondary to tuberculosis elsewhere in the genito-urinary tract, usually the kidney, so that the bladder, prostate and vesiculæ seminales are often involved. In these genito-urinary cases the infection often passes down the vas, but may travel down the lymphatics, and more rarely the blood vessels.

In all cases the earliest signs and main stress of the infection are manifest in the epididymis, the testis itself only being invaded in the later stages. Many authorities maintain that tuberculosis first commences in the globus major of the epididymis, but our experience would lead us to believe that the disease is first seen, at least as often, in the globus minor ; but in any case the whole organ becomes involved and rapidly caseates. Tubercles appear on the visceral, and later, parietal tunica vaginalis, so that a hydrocele develops, but this seldom reaches a large size, as adhesions occur early between the visceral and parietal layers. Tuberculous foci also develop along the vas, which appears thickened and nodular owing to the presence of localised tuberculous abscesses and fibrosis along its course, and this " beading " of the vas is characteristic of tuberculosis. Later tubercles appear along the seminiferous ducts of the testis, and coalesce and caseate, so that the whole organ becomes converted into a tuberculous abscess, lying inside the thickened tunica albuginea. In neglected cases adhesions occur between the two layers of the tunica and the skin, which becomes infiltrated and ultimately breaks down and discharges, leaving a persistent sinus leading down to the disintegrated remains of the testicle.

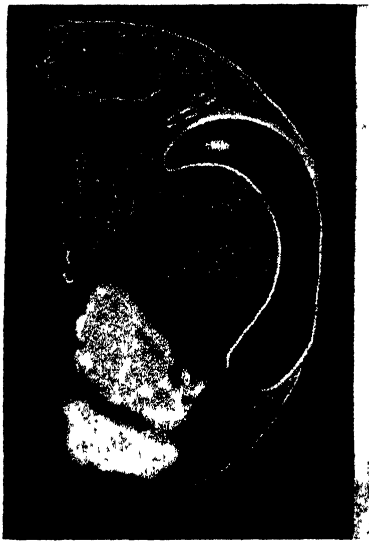


FIG. 324. Tuberculous epididymitis, with caseation in the globus minor.

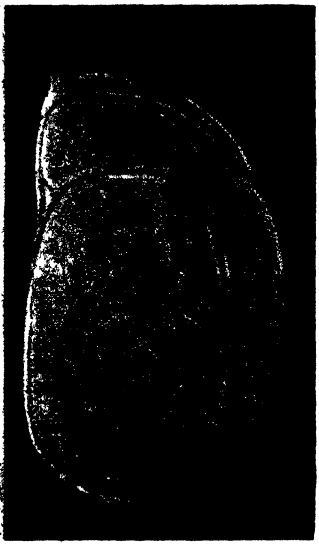


FIG. 325. Gummatous infiltration of the testis and epididymis. Note the hazy appearance of the tissue structure.

Clinically the onset is usually insidious, the patient's attention being drawn accidentally to the presence of a testicular swelling, while in many cases it escapes his notice, and is only found by the doctor when the patient comes up because of frequency of micturition resulting from the urinary tuberculosis (Chapter XX.). In a few cases, usually in small boys, the onset may be sudden, with a certain amount of pain and the appearance of a large hydrocele.

In both cases careful examination will show the epididymis to be generally enlarged and distinct, and the digital fossa to the outer side of the testis to be unduly obvious. The globus major and minor are very enlarged and feel irregular and craggy, while later, areas of softening and fluctuation can be detected. There may be some slight tenderness, but the condition is generally painless.

The testis feels normal and sensation is present, but in the later stages the whole gland may be enlarged, nodular or fluctuating, and then sensation will have disappeared. A small hydrocele is often present, causing fluctuation around the front and sides of the testicle, and this may be loculated from adhesions.

The spermatic cord is often firm and thickened, and " beading " of the vas is almost invariably present, while this cordlike structure can be felt unduly thickened and prominent at the posterior part of the cord. In the late stages the scrotum will be œdematous and adherent, and sinuses may be present, usually in its lower and back part where they are liable to be overlooked ; these are often multiple and present undermined edges with flabby granulation tissue, while flaky seropus exudes from them. If secondary infection be present, hernia testis may occur.

In some cases both sides may be affected, but one is always much more advanced.

Rectal examination should be made in all cases, when the prostate often will be felt hard and craggy, the vesiculæ on one or both sides may be irregularly thickened and nodular, and the bladder wall found to be thickened and infiltrated. In boys the lower ends of the ureters are palpable and one or both may be found to be thickened, a sure sign of infection of the kidney of that side.

Urinary examination and cystoscopy are essential, even when no urinary symptoms exist, and practically always yield positive results if carefully carried out. Ureteric catheterisation is necessary to ascertain from which kidney the tubercle bacilli come. Both may be involved.

Diagnosis is usually easy, the painless, craggy enlargement of the epididymis, associated with " beading " and thickening of the vas, an apparently normal testicle, and often urinary frequency, being characteristic of tuberculosis. In acute cases in children, however, mumps or trauma may be suspected at first, but if the condition does not settle down in a month tuberculosis should be suspected strongly and a thorough urinary examination conducted. In adolescents and adults syphilitic epididymitis may cause difficulty, while occasionally a neoplasm in the posterolateral portion of the testis closely simulates epididymal enlargement. Rarely a chronic septic epididymitis may deceive the surgeon.

Prognosis is never good, as the disease in the testis is always secondary to tuberculosis elsewhere, generally in the urinary tract.

Involvement of the second testicle usually occurs in from two to five years.

Treatment. This consists firstly in localising and, if feasible, removing the primary focus, which may often be a tuberculous kidney, when marked improvement or cure of the local condition generally follows. At the same time the testicle must be supported, best by strapping up the scrotum on the affected side, while tuberculin injections may be given with benefit in these cases (Vol. I., Ch. VI.).

If the disease progresses, orchidectomy must be carried out, and, as pointed out by Nitch, the inguinal incision can be prolonged upwards to permit of complete removal of the infected vas and vesicle in one mass, a proceeding which, though it increases the severity of the operation, is logical in dealing with a descending infection, and prevents the formation of the troublesome tuberculous sinus which so often occurs in the scar if this procedure is not carried out. This more severe operation is to be undertaken only by an experienced surgeon, and has been shown to give no better ultimate results than simple orchidectomy.

As recurrence on the opposite side is not uncommon after orchidectomy, some surgeons ligature the opposite vas when performing the removal of a tuberculous testis in the hope (often vain) of preventing contralateral spread.

Some surgeons recommend partial or complete removal of the epididymis in the early stages (epididymectomy), but this does not often give satisfactory results, as a sinus usually occurs in the scar, and recurrence is common in the testis, which is liable to atrophy owing to interference with its blood supply. It may be justifiable if one testis has already been removed.

If a sinus or hernia testis be present, orchidectomy is the correct treatment.

Syphilitic affections of the testis and epididymis occur both in the congenital and the acquired forms of the disease.

(A) *In the Acquired Form.* (1) In secondary syphilis (and early tertiary) a *chronic epididymitis* is not infrequent, and is characterised by a sudden hard and nearly painless enlargement of first one and then, about a week later, the opposite epididymis, the enlargement occurring first and persisting longest in the globus major. A hydrocele is usually present, and the condition frequently almost clears up and then repeatedly relapses.

The Wassermann reaction is, of course, positive, and other secondary manifestations (Ch. VI., Vol. I.) are usually present.

The condition may be mistaken for tuberculosis, though the craggy feeling, the greater enlargement of the globus major, the hydrocele, and the bilateral condition, combined with absence of " beading " in the vas, should prevent any mistake.

The relative painlessness and marked enlargement of the globus major should prevent gonorrhœal epididymitis being diagnosed, while mumps and chronic sepsis can be eliminated by careful examination for other signs of the disease.

(2) Tertiary syphilis always affects the testis more than the epididymis, but sometimes both may be involved extensively (Fig. 325), more often in a diffuse gummatous infiltration. As in all tertiary lesions, the gummatous infection may be localised or diffuse, but is usually bilateral, one organ being affected a week or so before the other.

Diffuse gummatous infiltration is much the more common, and usually affects only the testis, though in some few cases it involves the epididymis and cord. As in all such lesions, the structure of the tissues persists and is vaguely seen as through ground glass on section. A hydrocele is usually present and, though large, is lax, while as the condition is often bilateral the whole scrotum is much enlarged. The testis is generally involved, and presents an enlarged, painless, heavy, smooth, ovoid swelling, testicular sensation being lost early. Suppuration and caseation are rare in this variety of the disease, but fibrosis supervenes, with the result that the organ soon becomes shrunken, hard and atrophic, while sexual desire and power are, of course, lost.

A localised gumma occurs less commonly, and presents as a bulging, fluctuant swelling, usually involving one pole, though two or more foci may be present. The swelling soon caseates, showing the typical yellowish, structureless appearance on section, and, the skin becoming invaded, appears as a wash-leather slough at the bottom of a typical circular, punched-out, gummatous ulcer in the scrotum. Hernia testis rarely occurs, as the remains of the organ fibrose and healing occurs, with scarring. Hydrocele is often present, and both organs usually become involved.

Localised gummata may be mistaken for neoplasms.

(B) *In congenital syphilis* there is generally a diffuse gummatous epididymo-orchitis, which occurs in early infancy, both organs being enlarged, often to the size of a pigeon's egg, painless, and usually surrounded by hydroceles. This condition is seen often as early as the sixth week, but may not come on till puberty.

More rarely a pure epididymitis occurs in children from three to ten, and is subject to frequent relapses.

Treatment of all syphilitic lesions is on the lines laid down in Ch. VI., Vol. I.

TUMOURS OF THE TESTIS AND EPIDIDYMIS

Neoplasms of the testis proper are almost always malignant, and considerable confusion has existed as to their classification. Such tumours are mostly *seminomata* in young patients or in older subjects are *teratomata*, but inasmuch as one type of tissue may preponderate to a marked degree, so that a section passes through one tissue alone, they are often diagnosed as carcinoma, and less frequently as sarcoma, unless a series of sections are examined, when the mixed nature of the neoplasm becomes evident. *Carcinoma*, and less often *sarcoma*, do undoubtedly occur, but not with the frequency they are often reported, while occasionally a *hypernephroma* or chorionepithelioma may be met with in the testis.

FIG 326. Large neoplasm of a right undescended testicle in the same patient as depicted in Fig. 299.

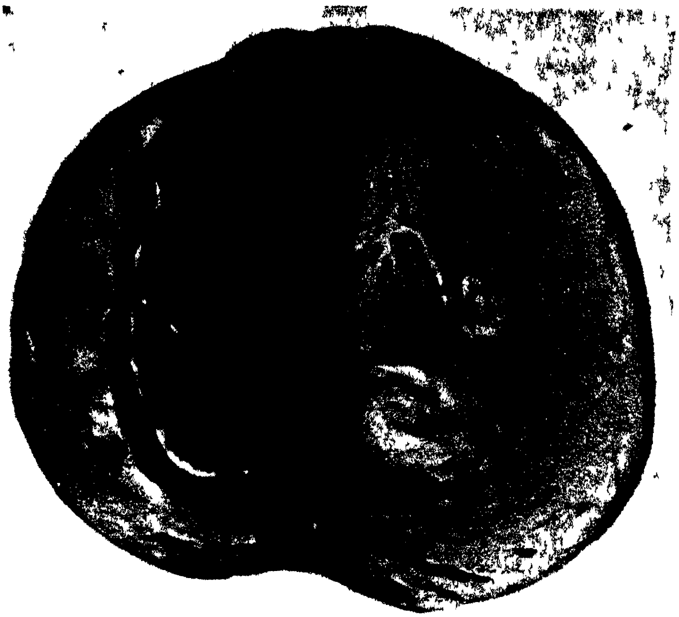


FIG 327 Section of the teratoma of testicle shown in Fig 326 showing invasion of the surrounding tunica vaginalis

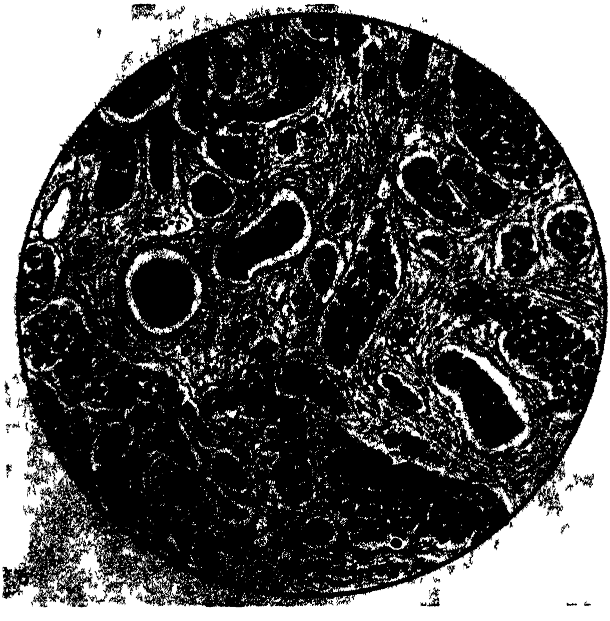


FIG. 328. Microscopical section of the same, showing multiple deposits of malignant disease, some of which are lying in the blood vessels.

(*a*) **Simple tumours** are rare and occur only in connection with the mediastinum testis, where a *lipoma* is very occasionally met with, and may reach the size of a cocoanut. The condition presents all the signs of a true testicular neoplasm, save that a hæmatocele is not present, and a long history can be elicited; so the diagnosis is not likely to be made except at operation, where, if small, enucleation of the lipoma may be feasible. Generally orchidectomy has to be resorted to. *Fibroma*, which may be soft or hard, also occurs in connection with the tunica albuginea or epididymis, and presents similar signs.

(*b*) **Malignant neoplasms**, as already stated, are usually **seminomata** or **teratomata**, when they may occur at any age after puberty, but seldom earlier, and are excessively malignant in the vast majority of cases, death occurring in from nine months to two years, often from cerebral metastases.

The majority of these growths are extremely soft and vascular, commence in the body of the testis, often towards its posterior aspect, and grow and disseminate rapidly. Lymphatic involvement is early and frequent, the upper aortic nodes being invaded as the lymphatics passing with the spermatic vessels drain the testis to the epigastric region; it is needless to remind the student, we hope, that *no enlargement of the inguinal nodes* is to be expected unless the scrotal skin is invaded, *i.e.*, in very late cases.

In a few instances these teratomata of the testicle have been accompanied by swelling and enlargement of the male breasts, which have become large, soft and tender.

On section the growth is deeply blood-coloured, and in the early stages often apparently encapsuled; there may be cystic spaces full of mucin or blood, and small papilliferous ingrowths frequently occur in these. Cartilage is usually present in small islets, and often areas of connective tissue of various types. Rarely hairs, embryonic teeth, skin and glandular elements, etc., may be detected with the naked eye, and much more often microscopically.

One particular type of teratoma, containing much fibrous tissue and many cystic spaces, into which epithelial proliferation often occurs, is much less malignant, possibly because of its dense fibrous structure. This type of teratoma is from its naked-eye appearance known as **fibrocystic disease of the testicle,** and has been described as a benign neoplasm; but no true capsule exists and metastases occur in time, while microscopically it is a typical teratoma, showing cartilage and many other types of tissue, even if these are not visible to the naked eye.

Carcinoma is the next most frequent growth, but is of uncommon occurrence and nearly always met with in men over forty. It cannot be diagnosed apart from serial sections, as carcinomatous elements often predominate in teratomata. The growth is usually spheroidal-celled in type, but columnar-celled carcinoma may occur in the mediastinum of the testis or epididymis. Lymph nodes in the iliac and aortic regions are early and extensively involved.

Sarcoma in the testis is very uncommon, most of those specimens so called in museums proving on careful section to be teratomata or carcinomata. The neoplasm usually occurs in infants, and is rare after puberty; it is most often of the spindle-celled type, but round-celled growths are not unknown. Lymphatic involvement is very rare, and its occurrence should always lead to the suspicion that the neoplasm is teratomatous; metastases usually occur in the lungs.

Hypernephroma is most uncommon and presents on section the typical yellow, lobulated appearance of this type of growth; it is presumably derived from Wolffian elements incorporated and dragged down in the development and descent of the testes, a theory strengthened by its occasional occurrence along the course of the spermatic vessels. The growth is only locally malignant and lymph nodes are not enlarged.

Clinically the signs manifested are very similar in all types of neoplasm. The onset is insidious, the testicle becoming the site of a gradually increasing painless swelling, at first localised to one part of the organ, but later involving the whole gland. As already mentioned, when the tumour starts in the posterolateral part of the testis, enlargement of the epididymis may be closely simulated. At the same time an effusion appears in the tunica vaginalis, the presence of which masks the testicular enlargement, so that the diagnosis of hydrocele may be made, unless the gland is examined after the fluid has been withdrawn by tapping (p. 953). The effusion in the tunica is usually serous, but often becomes bloodstained in the later stages, when the growth has involved the lining membrane; owing to its presence fluctuation will be detected at the front and sides of the ovoid scrotal swelling.

A hæmorrhage may occur into the neoplasm or tunica vaginalis, when a sudden increase of size and some pain are noticed, otherwise the patient seldom complains of more than a dragging pain, or of the bulk of the scrotal contents. Later the neoplasm bursts into the tunica and rapidly fills and distends the sac, which assumes its typical pyriform shape, but is, of course, solid and very heavy if taken in the hand; indeed, this undue weight of the testis can be detected in the early stages and is characteristic of neoplasm or gummatous infiltration. In the ultimate stages the tumour bursts through the tunica vaginalis, invades the skin and ulcerates as a soft fungating mass. In the later stages the whole cord is much thickened, and this can be noted early in cases where a carcinoma or teratoma, with much epithelial growth, causes lymphatic permeation of the cord to be a marked sign.

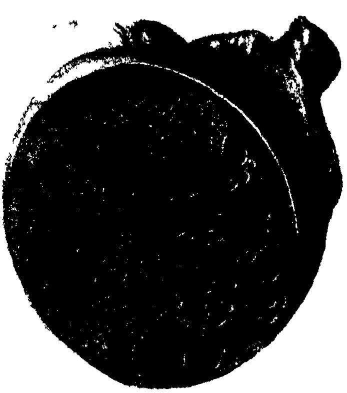


FIG. 329. Teratoma testis "fibro-cystic disease."

In advanced cases the enlarged retroperitoneal lymph nodes may be felt on abdominal examination and are usually to be palpated in the region of the renal pelvis, at which level the spermatic veins and lymphatics empty into larger channels. Metastases should be looked for in other tissues, notably the brain and lungs. As already stated (p. 935), any of these neoplasms may occur in a misplaced or undescended testis and are then more difficult of detection.

Diagnosis between the various types of neoplasm is impossible before operation, though in teratomata testis a positive Aschheim Zondek test is sometimes obtained, and is moreover unimportant, as immediate orchidectomy is indicated in all cases. In any male over puberty teratoma is the likely diagnosis, but over forty carcinoma is increasingly likely in direct proportion to the age of the patient. A long history is in favour of fibrocystic disease. Sarcoma is most common in infants. Gummatous disease of the testicle, both in adults and infants, is very likely to cause confusion in diagnosis, and often this can be solved only by an exploratory operation, which should be performed promptly in any case of doubt. Careful examination for other signs of syphilis, the presence of a positive Wassermann reaction, and, above all, the bilateral nature of the gummatous lesion generally, may render such a step unnecessary.

Occasionally tuberculous epididymitis may be diagnosed, but the onset of a hydrocele and the absence of tubercle bacilli from the urine and genito-urinary tract should lead to grave suspicion that a malignant neoplasm is present. It must be remembered that in both conditions there is likely to be a slight nocturnal rise of temperature. Exploration must not be delayed if any real doubt exists.

There is always a danger that a hydrocele may be diagnosed, and unless the testis is carefully palpated after tapping the presence of a neoplasm may be overlooked. Bloodstained fluid or blood, if present, should lead to a very careful examination, as unless there has been definite trauma with a fairly sudden effusion, the presence of a hæmatocele is most suspicious of malignant disease of the testicle, and that usually in an advanced state.

Prognosis. This is always grave, the majority of cases dying from metastases, often cerebral, in about a year from the onset of the tumour. Cases seen when the classical hard pyriform swelling occupies the invaded and distended tunica vaginalis may be regarded as inoperable from a curative viewpoint, though it is justifiable to remove them so as to prevent a large ulcerating mass developing. From the foregoing it is obvious that early diagnosis and prompt removal are necessary if a cure is to be hoped for.

The *treatment* consists in orchidectomy through an inguinal incision, the cord being divided as high as possible. Some surgeons advocate a very extensive removal of the iliac and aortic glands, but the collapse is severe and the mortality high, while judging from results the ultimate prognosis does not seem to be improved. Where abdominal glands are present, and even if they cannot be felt, deep X-ray therapy may be of value.

Simple neoplasms of the epididymis occur very rarely, but both *fibroma* and *lipoma* have been reported. The condition is generally diagnosed as tuberculosis or teratoma, but *no* beading of the vas occurs. *Carcinoma* also occurs very rarely.

CYSTS OF THE TESTIS AND EPIDIDYMIS

Dermoid cysts are not infrequent, and usually take the form of distension of the sessile and pedunculated hydatids of Morgagni, on the upper pole of the testis. These can be palpated as tense ovoid swellings, which may reach the size of a pea and are situated on top of the testicle. They call for no treatment unless causing mental distress, when they should be excised, the gland being approached through an inguinal incision as for hydrocele (p. 954).

Rarely a dermoid comparable to the ovarian dermoid cyst, and in reality a teratoma, is met with.

Retention cysts occur in the tubules of the mediastinum testis and epididymis of elderly men, and present as slowly enlarging ovoid swellings, usually near the upper pole of the gland. Such a condition is known as a **spermatocele,** a condition usually met with in elderly men and frequently bilateral, the patient's attention being drawn to the presence of an abnormality by a sensation of fulness and discomfort in the testis. The condition arises from the blocking of the ducts of the epididymis, with subsequent distension of the tubules behind, so that one or more rounded cystic swellings occur in the course of the epididymis. These are usually around the upper and back part of the testis and may be found to vary in size from a pea to a chestnut; occasionally such swellings may arise from distension of the vestigial hydatids of Morgagni at the upper end of the testis, in which case they may be seen in younger subjects.

Treatment consists in aspiration or excision of the thin-walled cysts from the surrounding epididymis, an easy task if no inflammatory reaction is present, the testis being exposed through an inguinal incision, as for hydrocele. The tunica vaginalis usually needs incision to expose the cyst, and it is wise to leave it evaginated as described in order to obviate the risk of a hydrocele consequent on the handling at operation. The condition of spermatocele is not in itself dangerous, but removal of the tense cyst causes both physical and mental relief to the elderly patient, and is therefore advisable, although recurrence, usually from formation of new cysts, is by no means uncommon. Operation on both sides is liable to be followed by sterility, though it is somewhat comparable to Steinach's operation, in that it is often followed by a temporary improvement in both general and sexual power.

Parasitic cysts are occasionally met with.

DISEASES OF THE VAS DEFERENS, SPERMATIC CORD AND VESICULA SEMINALIS

Diseases of these structures, as already pointed out, usually accompany and often precede in appearance (*i.e.*, in descending infections) the actual occurrence of the disease in the testis and epididymis, though the condition is seldom diagnosed in this early stage.

Inflammation of the vas (funiculitis), or more often of the lymph vessels around it, sometimes occurs in acute gonorrhœa, when a localised red, œdematous and tender area appears in the inguinal canal or just below it; fluctuation usually develops and heralds the onset of suppuration in the area. The epididymis is frequently rapidly affected. Chronic infection is almost always *tuberculous* in origin, and numerous localised abscesses and areas of fibrosis occur both in and around the vas, constituting the " beading " so typically seen in and often actually preceding tuberculous epididymitis. Later these areas coalesce and the whole vas is converted into a tube of tuberculous granulation tissue containing caseous material; this renders the removal in toto, as advocated by Nitch, of the entire length of the vas and vesicle essential if a tuberculous sinus is to be avoided after orchidectomy in such cases.

Inflammation of the seminal vesicles is always secondary to urethral and prostatic infections.

Acute vesiculitis may occur from pyogenic infection, and more usually in acute gonorrhœa.

Clinically there is pain and a feeling of fulness in the anus and perineum, and " prostatism " is frequently present, as also epididymitis. Tenesmus, constipation and sphincter spasm of the anus are common, but not so marked as in prostatitis. Hæmospermia is sometimes seen.

Rectal examination is painful and shows one or usually both vesiculæ to be enlarged, soft and very tender, while fluctuation may be detected.

Treatment consists in keeping the patient in bed and treating the gonorrhœa. Abscesses usually burst into the urethra, but should pus be detected around the vesicle prompt drainage from the perineum is called for, as if the pus bursts into the rectum troublesome chronic infection is likely to result.

Chronic vesiculitis is usually a complication of a chronic gonorrhœal prostatitis, but sometimes may be septic in origin, in which case it commonly occurs after prostatectomy, when trouble is often experienced from the suprapubic wound repeatedly breaking down after healing.

Clinically the signs are those of chronic prostatitis (p. 916), and on rectal examination the vesiculæ can be felt enlarged, often nodulated, and rather tender.

The *treatment* consists in stripping the vesicles daily during the process of prostatic massage by the rectum. In septic cases after prostatectomy, excision, best by the transvesical suprapubic route, will have to be carried out.

Tuberculous vesiculitis is by no means rare in genito-urinary tuberculosis, and can be detected in most cases of tuberculous epididymitis and prostatitis.

On examination one and sometimes both vesicles can be felt per rectum to be hard, enlarged and nodular, and in the later stages as an infiltrated plaque-like mass lying above the prostate.

The condition gives rise to no special symptoms, and seldom ulcerates into the bowel.

Treatment. The urinary condition calls for investigation, and the vesicle, if one alone be involved, may be excised, together with the vas and testis, through an inguinal or suprapubic incision.

The pampiniform plexus may be thrombosed by trauma (hæmatocele of the cord) or in infections, when the cord is thickened and tender to the touch, and the clotted vessels can be felt as hard cords. In such cases rest may be secured by the use of a suspensory bandage and any focus of infection suitably dealt with.

Varicocele. The ætiology of the varicose condition of the veins of the pampiniform plexus, which is known as varicocele, is often obscure, though its more frequent presence on the left side of the body suggests that the right-angled opening of the left spermatic vein into the renal vein renders its radicles more liable to obstruction than the sloping opening of the right spermatic into the inferior vena cava. The condition is undoubtedly aggravated in constipated individuals by the drag of the loaded sigmoid colon and rectum, compressing and distorting the left spermatic vein as it crosses the pelvic brim just behind the pelvirectal junction. Varicocele may occur secondarily to neoplasms of either kidney obstructing the venous return into the renal vein, or to carcinoma of the pelvirectal region, causing similar congestion, while more rarely retroperitoneal teratomata or sarcomata may cause varicosity of one or both pampiniform plexuses. If a varicocele occurs on the right side, it is probably due to a right renal growth. In every case, therefore, especially where the history of onset of the varicocele is sudden, the urine should be examined for blood and the abdomen be palpated carefully. Should one of these primary causes be discovered it obviously calls for urgent treatment by removal, if possible, when the secondary scrotal condition certainly will improve.

In the majority of cases, however, unilateral varicocele, usually left-sided, exists with no obvious cause, even constipation being absent, and in these cases it cannot be urged too strongly that no treatment is called for unless the condition is causing pain and discomfort to the patient. Unless his attention is directed to it and his mind disturbed by unfounded tales of danger of impotence if the condition be left untreated, he is rarely troubled by its presence.

Clinically the condition is easily recognised and usually unilateral and left-sided, the distorted, tortuous and distended veins giving a typical appearance, often likened to " a bag of worms " within the pendulous scrotum. The patients are often young, anæmic and neurotic, and complain of intense pain in the testis, abnormal sexual feelings, impotence or asthenia. On examination the testis is often smaller than the one on the opposite side, while a small hydrocele may be present.

Careful rectal and abdominal examination must be made to exclude the possibility of any organic lesion elsewhere, and the heart should be examined.

Treatment. In some few cases, especially in hot countries and in patients taking riding exercise, if the scrotum be pendulous, pain and a congested feeling result from exertion, and it is then, as also in candidates for the services where a varicocele may be used as a cause of malingering, justifiable to interfere.

In elderly patients, all that is usually necessary is a well-fitted net suspender to support the scrotum against the perineum; this need be worn only during the day, and is a source of comfort to the patient. Suspenders are not to be recommended in the case of neurotic young men, as their presence tends to concentrate the patient's attention on his genitalia. In those cases where a suspender is ill-tolerated, or where the patient is a candidate for one of the services, operation may be undertaken and the main mass of the pampiniform plexus ligated. Recently the injection of quinine and similar drugs has been successful in clotting the veins; these are used as advocated in Ch. X., Vol. I., but are not without risk of sloughing.

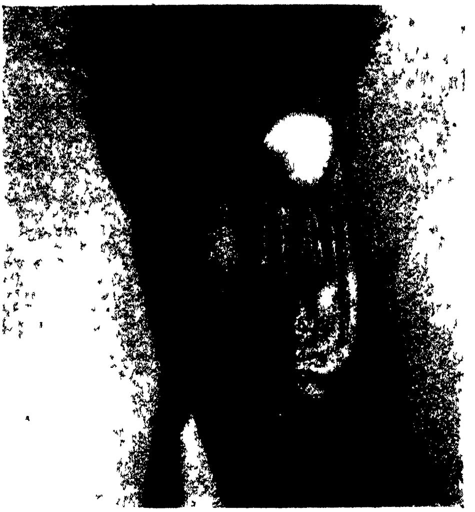


FIG. 330. Varicocele.

Operation. The pubes having been shaved and purified, the patient is anæsthetised, and a short incision made upwards and outwards from the pubic spine on the affected side so as to expose the spermatic cord as it passes out of the external abdominal ring and down into the scrotum; there is no need to open the inguinal canal by incising the external oblique aponeurosis. The cord is elevated on a retractor and the fascial sheath around it opened longitudinally, the cremaster muscle fibres separated, and the vessels exposed. The vas deferens, lying behind the main mass of the pampiniform plexus, should be isolated together with the deferential artery and venules which closely accompany it. The veins are now held up on the retractor, and search made for the spermatic artery, with which are usually associated one or two smallish veins; when found, this also should be isolated together with the accompanying veins, but no very prolonged search should be made for the vessel, as, although its ligature is not desirable, actual atrophy of the testis rarely follows. The remaining veins of the plexus are now dissected clear of the vas and artery for about two or three inches, ligated at the upper and lower limits of the cleared space, and the intervening mass removed, care being taken not to cut them within a quarter of an inch of the ligature for fear of this slipping off. A stitch is now passed through the parts of the veins distal and proximal to the ligatures, and these are approximated, a proceeding which holds up the testicle and saves the patient much discomfort and the need of a permanent post-operative scrotal support. We do not consider it necessary to evaginate the testis through a slit in the tunica vaginalis, as the occurrence of a hydrocele of the tunica vaginalis consequent on the cutting off of the venous return is rare if the operation is carried out as described above. The patient should be kept in bed for five or six days, after which he may be allowed up, wearing a well-fitting net suspender, which must, of course, be fitted after the operation. The use of this suspender is a great comfort to the patient for the first fortnight after operation, when its use should be discontinued, except in cases where the patient is indulging in occupations such as riding or bicycling, where friction occurs to the scrotum and perineum ; if this is so, the suspender should be worn for at least a month after operation, and on all occasions when such exercise is indulged in.

Neoplasms of the cord, apart from invasion and thickening secondary to growths of the testis, are rare, and when they occur are usually simple, *fibroma* and *lipoma* being the most common.

Lipoma may occur not infrequently around the fundus of a hernial sac in obese patients, and is then probably an overgrowth and condensation of the extraperitoneal fat rather than a true neoplasm. In some cases, on the other hand, a lipoma may simulate an inguinal hernia (bubonocele) very closely, and the diagnosis often can be made only at operation, when the tumour is dissected away.

AFFECTIONS OF THE TUNICA VAGINALIS

Any disease of the enclosed testis and epididymis usually will be reproduced in the tunica vaginalis by direct extension, while if the connection with the peritoneum remains patent a similar condition of affairs will occur secondary to disease of that membrane. As a consequence of the irritation of the serous lining of the tunica, fluid is secreted and distends the space between the visceral and parietal layers (unless this has been previously obliterated by adhesions, as is usual in tuberculosis), and a secondary hydrocele results ; this may be sudden in onset (acute hydrocele) or accumulate gradually (chronic hydrocele).

HYDROCELE

Various types of hydrocele are met with in the male :—

(1) **Diffuse hydrocele of the cord** is a rare multilocular cystic condition of the whole scrotal extent of the spermatic cord, often extending up through the inguinal canal into the abdomen, and is due either to the persistence of loculated remains of the processus vaginalis or to a lymphangioma. The treatment consists in dissecting the mass away from the cord, by no means an easy task.

(2) **Hydrocele of an unobliterated processus vaginalis (congenital hydrocele)** is a condition met with in young children and usually only diagnosed when there is some coexistent inflammatory condition of the peritoneal cavity, such as tuberculous peritonitis, which causes fluid to be exuded and gravitate into the vaginal sac. Congenital hernia is usually also present unless the opening in the neck of the sac is too small to allow of the passage of bowel or omentum ; it is a fruitful source of misdiagnosis, the best point in differentiating the two conditions being the slowness with which the hydrocele fills and empties and the absence of resonance in the fluid swelling. In a young child both conditions will be translucent.

Treatment consists in excision of the sac through an inguinal incision, as for hernia ; should tuberculous peritonitis coexist, operation should be put off till this has been cured, as not only is there grave danger of a tuberculous sinus following operation, but a spontaneous cure may result.

(3) **Encysted hydrocele of the cord,** due to persistence of the middle portion of the processus vaginalis, presents as an ovoid swelling in or just below the inguinal canal ; if in the canal it may be mistaken for a bubonocele, but has

no expansile impulse on coughing, and often can be drawn down out of the canal by gentle, firm tension on the testicle and cord, when the upper limit of the mass can be defined. Rarely chronic suppuration in the course of the cord, following gonorrhœa or tubercle, may cause a similar pyriform cystic tumour. *Treatment* consists in cutting down on the swelling through an inguinal incision and dissecting it off the cord, a difficult task since the membrane is thin and friable.

(4) **Bilocular hydrocele** results when an effusion occurs into a processus vaginalis which is closed above, and has also a communicating loculus lying in the retroperitoneal, or intramuscular tissues. The fluid can be expelled on pressure from the scrotum to the deeper sac, and *vice versâ* on coughing or straining when an expansile impulse is present. Inguinal hernia is thus closely simulated, and will be diagnosed unless the swelling is transilluminated. *Treatment* consists in excision of the sacs. The condition is rare.

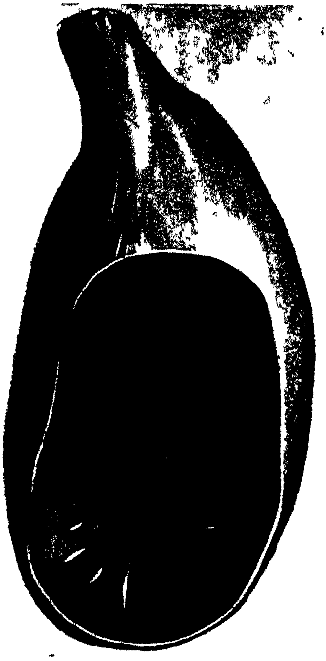


FIG. 331. Hydrocele of the tunica vaginalis.

FIG. 332. Large right hydrocele, superficially resembling a right inguinal hernia, but showing no fulness in the groin.

(5) **Hydrocele of the tunica vaginalis** (hydrocele) may result from effusion into the tunica vaginalis secondary to some disease of the testis, or obstruction to its venous return (secondary hydrocele), or may be the result of primary irritation of the lining membrane of the sac. It can be diagnosed by its translucency and tapering upper end.

Clinically the signs are identical in both primary and secondary hydrocele. The scrotum, usually on one (the right), but sometimes on either side, is occupied by a smooth pyriform swelling not adherent to the skin. The affected side is of course enlarged, and its size will vary with that of the hydrocele from an egg to a cocoanut or even larger, in extreme cases reaching halfway to the knees.

On examination the swelling is fluctuant, and testicular sensation can be elicited usually on pressure being applied to the posterior aspect of the swelling in its lower part, *i.e.*, where the testis is not surrounded. The pyriform mass tapers above, and although the upper end may pass up into the inguinal canal usually it can be defined and the spermatic cord felt to be normal in size and consistency above it. There will be no expansile impulse on coughing, unless the hydrocele is of the congenital type, which is uncommon. On examining with a light placed behind the scrotum, the swelling is seen to be translucent, except in those old-standing cases where the wall is much thickened. If very large, the skin may be lifted off the penis, which is partly or entirely lost to view, its place in extreme cases being taken by an invagination of the skin.

The *diagnosis* between primary and secondary hydrocele is discussed below. *Hæmatocele* can be eliminated by the presence of translucency, the absence of a heavier and thicker feel of the swelling, and often of a history of accident. *Hernia* is to be excluded by the absence of expansile impulse, and if it is reducible, by being unable to return the mass to the abdomen. Translucency is also helpful in diagnosis, but it must be remembered that in infants gas-distended gut is translucent. If the neck of a hydrocele can be defined, the condition should not be confused with strangulated hernia, where in addition the scrotum is tense, œdematous and tender, and constipation and vomiting will be present. *Large spermatoceles* may give trouble but they are situated above and behind the testes which can be felt separate from and in front of the translucent swelling.

Occasionally a spontaneous cure will result from **rupture of the hydrocele** after violence, when the swelling is large. There is then usually some bruising of the scrotum, which is tense and feels as if it has been injected with gelatin, owing to the infiltration of the cellular contents with the clotted hydrocele fluid.

(6) **Secondary hydrocele** may result from (*a*) acute or chronic inflammation of the testis or epididymis, as in gonorrhœa, tuberculosis, or syphilis; or (*b*) follow on a testicular tumour. In the acute cases there is pain, and examination of the testis and adnexa after " tapping " the hydrocele reveals that they are enlarged. The condition also may be present, as a bilateral affection, in cases of ascites due to advanced cardiac and renal disease, carcinoma of peritoneum, retroperitoneal tumours, and chylous ascites (when the hydrocele fluid is also milky) due to lymphatic obstruction in filarial elephantiasis and blockage of the thoracic duct.

Treatment in all these cases must aim at the eradication or alleviation of the primary disease, no local treatment other than tapping being indicated.

(7) **Primary or idiopathic hydrocele** can be diagnosed safely only when the foregoing conditions, and the possibility of a hydrocele in the fundus of a hernial sac, or even an irreducible hernia, have been eliminated.

The *treatment* of the condition is operative and should, except in very old or debilitated patients, aim at effecting a radical cure by removal of the secreting membrane, though tapping may often be necessary as a diagnostic step.

Tapping. The patient should be seated or, better, lying on a bed or couch for this operation. The position of the testis having been ascertained (usually by touch and the patient's sensation, though transillumination may afford valuable indication of its position), the pyriform scrotal swelling is grasped in the palm of the hand, and the penis being held away by the thumb the skin is made to stretch tensely over the mass. The scrotum is now painted with 2 per cent. iodine in spirit, and an area on the front free from veins being selected, a sterile trocar and cannula are plunged in, the trocar withdrawn, and the fluid allowed to escape through the cannula, the hand being used to press out the fluid toward the cannula. The trocar needs plunging sharply through the tense skin and tunica, both of which it can be felt to pierce, and then a sense of loss of resistance is encountered as it enters the fluid. The common source of inability to obtain fluid is that, owing to the skin not being held tense and insufficient force used, the trocar slips along the outer surface of the tense tunica between it and the skin, while occasionally it is plunged into the testis, as evidenced by the patient experiencing sickening pain, when it should be withdrawn immediately and reinserted smartly elsewhere.

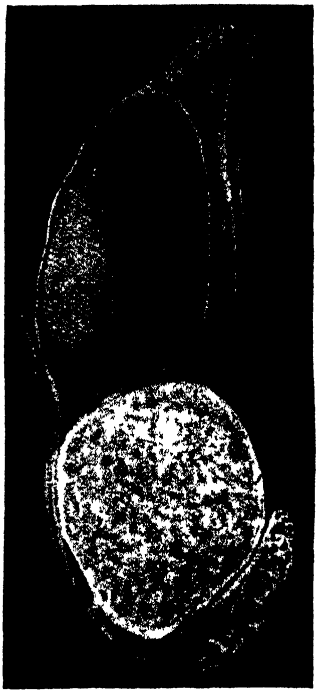


Fig. 333. Residual hydrocele after attempted cure by carbolic injection.

When no more fluid escapes, the cannula is withdrawn and the opening sealed with gauze and collodion. Some surgeons, prior to withdrawal, insert a few minims of irritant fluid such as pigmentum iodi, 5 per cent. quinine, or strong carbolic, which is massaged around, with the object of destroying the endothelial lining and so effecting a radical cure. This proceeding causes some pain, and the results are not on the whole satisfactory, as loculation very often occurs, following partial obliteration of the sac by the adhesions.

Operation for Radical Cure. A short incision is made upwards and outwards from the pubic spine ; the scrotal route is in theory to be avoided, as not only is the skin difficult to approximate accurately, with consequent delay in healing, but fouling of the wound, with consequent sepsis, is very liable to occur during the use of the bedpan and urine bottle. In practice, however, scrotal incisions heal well. The sac of the hydrocele having been exposed in the depth of the incision, it is pressed well up into the wound from below and held there while it is incised alongside the cord. A fairly free incision should be made and the stream of fluid directed into a bowl, pressure being meanwhile maintained on the scrotum to empty the sac. The wound is mopped out and the edges of the sac grasped in forceps, and the whole tunica and testis pulled up through the wound and separated gently from the surrounding cellular tissue, in which all bleeding points must be secured if a hæmatoma of the scrotum is to be avoided. This is a serious complication in that it is very liable to infection, with resultant sloughing of the testis ; unless, therefore, absolute hæmostasis is assured, it is well to drain the scrotum for twenty-four hours through the lower end of the incision by means of a corrugated rubber drain. Two methods are in vogue for the treatment of the tunica vaginalis, which is now freely exposed, lying on gauze outside the wound :—

1. The simpler method, recommended by Winkelbaum, can be practised only on thin-walled hydroceles, and consists in everting the testis through the hole in the tunica vaginalis, which is thus turned inside out and secured in this position by a few stitches passing behind the cord and epididymis. The whole rather bulky mass is returned into the scrotum and the wound closed, the object being to secure adhesions between the endothelial lining and scrotal cellular tissue, and so ensure granulation and destruction of the former. The disadvantage of this method is that sometimes the endothelium grows over the cellular tissue and a pseudo-tunica is formed, becomes filled with fluid, and recurrence results ; this is the more likely to occur if a small hæmatoma has been present. The tunica vaginalis behind the testis may give rise to a bulky swelling. The percentage of recurrences recorded is however small, varying from 1 to 15 per cent.

2. The surer method consists in snipping away the whole of the parietal portion of the tunica vaginalis, an easy operation, but one accompanied by severe bleeding from the numerous vessels in the tunica. It is advisable to under-run the entire cut margin by a continuous glovers' stitch of catgut to prevent a scrotal hæmatoma. The testis is then returned to the scrotum and the wound closed, with drainage for twenty-four hours if hæmostasis is incomplete. This excision with advantage may be carried out with the diathermy knife when hæmostasis is ensured.

The wound should be dressed with gauze, retained in position by a suspensory bandage, which acts also as a scrotal support. The patient may get up in four or five days, but should wear a suspensory bandage for two or three weeks.

Hæmatocele. The cause of a hæmatocele is nearly always a sharp blow or injury, or sometimes damage to a vein when tapping a hydrocele; it may occur also as a complication of a malignant tumour of the testis, or in blood diseases such as hæmophilia, scurvy, or severe anæmia. Since in this latter type of case local treatment would be disastrous, a blood count should be done if there is any doubt.

Clinically the tumour presents as a pyriform swelling in the scrotum, which may show subcutaneous bruising, and it can be diagnosed from a hydrocele by the fact that it is not translucent, and from a hernia by having no expansile impulse ; moreover, its upper limit is defined.

Treatment in a recent case consists in supporting the scrotum in a tight suspender, or by strapping, and resting the patient in bed in an endeavour to limit the bleeding. Tapping should be avoided, if possible, for at least forty-eight hours, as it tends to cause recrudescence of the bleeding; but it should be practised as a routine after that time has elapsed. After the blood has been withdrawn the affected side of the scrotum should be strapped with zinc oxide adhesive plaster for four or five days, being previously shaved in an adult.

In older cases, where clotting has already occurred and thickening of the tunica has resulted, the only satisfactory treatment is operation by the inguinal route as for radical cure of hydrocele, and excision of the parietal tunica vaginalis. In very old-standing cases, where extreme thickening and fibrosis of the tunica and scrotal tissues exist, this operation may not be practicable ; in such a case orchidectomy may be undertaken, since the testis is usually atrophied and disorganised. The wound should be drained for twenty-four hours, whichever course is adopted, since oozing from the scrotal cellular tissue is almost impossible to control. Such old-standing cases are not infrequently diagnosed as neoplasms of testis, and it is practically impossible to be certain that a testicular tumour does not coexist with the hæmatocele ; for this reason orchidectomy should be carried out as the operation of choice.

DISEASES OF THE SCROTUM

The scrotum is liable to diseases such as occur anywhere in the skin and subcutaneous tissue, and owing to the lax connective tissue beneath it great œdema will manifest itself rapidly, while the absence of subcutaneous fat and the presence of the dartos muscle cause the skin, when stretched over this œdematous mass, to be liable to become gangrenous.

Acute Infection. *Cellulitis* of the scrotum may occur after infection of wounds, but is most usually the result of extravasation of urine beneath Colles's and the dartos fasciæ (Chapter XX., pp. 861 and 896). Erysipelas may occur in this situation.

The whole scrotum is red, œdematous and much swollen, and patches of gangrene often occur in the skin in the lower part, while the whole integument may slough, exposing the tunicæ vaginales surrounding the testes.

Treatment. Early and free incisions into the cellular tissue are called for, and will result usually in amelioration of the local condition. The area should be dressed with dry sterile gauze and the patient sat in a hot bath for ten minutes twice a day. If the skin sloughs the scrotal contents must be dressed, and granulation and epithelialisation are usually so rapid and complete that recourse has seldom to be had to skin grafting or plastic surgery.

Chronic infection may occur as the result of eczema, or dribbling of urine from a penis lost in a scrotum distended by a hydrocele, hernia, or in elephantiasis. The skin may be infected by the bursting of an abscess in the testis or epididymis, when owing to the small size of the hole in the tunica albuginea and tunica vaginalis preventing the escape of a slough a sinus or a hernia testis is likely to be present.

FIG. 334. Sebaceous horn on the scrotum arising from an infected sebaceous cyst.

Lupus may appear occasionally on the scrotum, but tuberculous ulcers usually form only at the mouths of sinuses leading down to a disintegrated tuberculous epididymis.

Syphilis. The primary sore, secondary rashes, and gummata, either of the skin or secondary to ulceration of the testicle, are all met with on the scrotum and present the appearances characteristic of these lesions.

Elephantiasis is very marked here, secondary to filariasis.

Œdema is met with in advanced renal, cardiac and malignant disease, when the skin of the penis is also involved, and that organ often assumes a spiral twist.

Neoplasms of the scrotum, apart from carcinoma, are very rare. *Sebaceous cysts* are not uncommon and *dermoids* may be met with on the raphé. Both are treated by excision.

Carcinoma of the scrotum is of the squamous-celled type (epithelioma) and is seen especially in cotton spinners, tar workers and chimney sweeps; in

Scotland it occurs frequently in paraffin and shale workers, where its onset is preceded by a characteristic "occupational" dermatitis. It usually commences as an indurated scaly patch, which spreads slowly and breaks down to form a typical malignant ulcer with hard, raised, everted edges. The course is very chronic and the prognosis correspondingly favourable. The inguinal lymph nodes on one or both sides become involved later on in the disease and present a typical matted, fixed mass, without marked enlargement till the later stages.

Treatment consists in excision of the growth, with an inch margin of normal skin around, and the inguinal nodes in one mass.

THE DIFFERENTIAL DIAGNOSIS OF SWELLINGS OF AND IN THE SCROTUM

Inasmuch as the student frequently experiences difficulty in diagnosing between the various swellings in the scrotum, it may be well to indicate briefly the main points by which these are differentiated.

(A) If the whole scrotum is swollen and the skin œdematous, with perhaps gangrenous black patches, then (1) if there is œdema of the lower limbs, back and abdomen, look for *advanced cardiac, renal* or *malignant disease ;* (2) if the swelling is limited to the scrotum, penis, perineum, and possibly lower abdomen, but does not go down into the thighs, suspect *rupture of the urethra* and *extravasation of urine ;* but (3) if the swelling is confined to the scrotal integument alone, look for some local source of infection, not forgetting a *sinus* leading from and fixing the testis to the skin, nor omitting to remember the possibility of *erysipelas* in this region.

(B) If the skin be normal, examine the upper end of the scrotum to ascertain if the upper limit of the swelling is defined.

(1) If the neck of the swelling is large and passes up the inguinal canal into the abdomen, then *inguinal hernia* is to be diagnosed, and this is confirmed if an expansile impulse be present, the percussion note is resonant, or the swelling can be reduced on manipulation.

(2) If the neck tapers and the fingers can meet above it around a normal spermatic cord, even if only when the mass is drawn from the inguinal canal, then a *hydrocele* or *hæmatocele* of the tunica vaginalis is present. This is confirmed by noting the pyriform shape of the swelling. *Hydrocele of the cord* may be diagnosed when an ovoid swelling, the upper and lower limits of which can be identified, is present in or below the inguinal canal. *Hæmatocele* usually occurs after an accident, and the swelling is not translucent. *Hydrocele* is of insidious onset in most cases and, unless of very old standing, is translucent. Such a hydro- or hæmatocele should be tapped with a view to ascertaining if the condition is secondary to disease of the testis or epididymis, in which case these will be felt to be enlarged. *Spermatocele* may reach considerable size and cause confusion, but can be distinguished from a hydrocele by being above and behind the testes which can be felt separate from the translucent swelling.

Testicular enlargement may exist, however, without a hydrocele being present, and then the ovoid swelling can be felt larger than normal and greater in size than its fellow, if this be unaffected.

The common causes of this condition are *gummatous orchitis,* when both testes are affected and insensitive, while a lax hydrocele is present, and *neoplasms,* which usually occur in young men and have a characteristic heavy feeling. The orchitis of mumps is secondary to enlargement of the salivary glands.

Epididymal enlargement occurs in acute infection from gonorrhœa, when there is extreme tenderness, but the urethral discharge has often ceased, though the meatus looks red.

Chronic enlargement, when the epididymis can be felt as a thickened cord around and behind the testis, may be due to (*a*) chronic sepsis in old men; (*b*) to tuberculosis in young men and adolescents, when the swelling is craggy and " beading " present on the vas; or (*c*) secondary syphilis, when other signs of the disease will be present.

Torsion of the spermatic cord gives rise to a rounded, tender swelling, often of an undescended testis and usually in a youth or boy, who may give a history of injury and usually vomits.

Sinuses are often present in the back and lower part of the scrotum, and so are liable to be overlooked unless it is noticed that the testicle is adherent to the skin; they follow the discharge of an abscess in the testis or epididymis from any cause. Fungus testis, with its prominent mass of granulation tissue, may be associated with or precede sinus formation.

IMPOTENCE AND STERILITY

These are two disorders of the sexual function, sterility being the inability to achieve pregnancy, and impotence the inability to perform sexual intercourse to its completion. Either sex may suffer, and often does, from sterility, but impotence is practically confined to the male, as the female may be able to have intercourse and even become pregnant without an orgasm occurring.

Sterility in the Male. This is by no means uncommon and is usually due to organic disease of the sexual organs. In many cases the patient is perfectly potent and able to perform the sexual act with production of semen and satisfaction to himself and his partner, but no living spermatozoa are present. This is due usually to no spermatozoa being formed by the testes as a result of atrophy, non-descent, exposure to X-rays, or other diseases of both testicles. In other cases spermatozoa cannot reach the vas deferens and vesicles owing to the tubes being blocked; either the vas or the small tubules which lead from the testes to the epididymis may be blocked, and this is nearly always the result of past inflammatory disease, usually gonorrhœal in nature. In some cases ejaculation of prostatic fluid can still occur, but others will be seen where, even though an orgasm occurs, no semen is ejaculated owing, perhaps, to a urethral stricture, enlarged prostate, prostatic calculus, or other organic obstruction. In such a case the semen flows backwards into the bladder, and is later passed with the urine.

In any case of an unfertile marriage it is just as important to examine the husband as the wife, and the first step to be taken is to examine the seminal fluid microscopically to see if living spermatozoa are present.

Many cases of sterility due to the above causes are temporary or intermittent. For sterility in the male there is very little treatment other than that of improving the general health.

Impotence. In true impotence the patient has his normal sexual desire, but for one reason or another is unable to perform copulation satisfactorily. Total absence of sexual desire is not really impotence, but *frigidity.*

Impotence may be due (1) to inability to obtain an erection ; (2) an erection may be obtainable, but may last only a very short time and pass off before the orgasm can be completed ; (3) the erection may be normal, but ejaculation and orgasm may occur almost at once before introduction of the penis can be effected ; (4) though erection and insertion may be normal, there may be no ejaculation, or ejaculation may be very late and occur after the erection has passed off ; (5) there may be some mechanical hindrance to coitus due to organic disease of the penis, such as epispadias or hypospadias, while the erection may be crooked or misshapen as a result of scar tissue in the corpora cavernosa.

It will be seen, therefore, that many cases of impotence are due to actual organic disease in the penis, urethra, testicles, and above all the central nervous system. For lesions of the nervous system affecting the lumbar spine, or the nerves of the cauda equina or sacral plexus, may produce any of the above effects. Excessive use of certain drugs will produce similar results ; thus opium, cocaine, alcohol, camphor and arsenic in excess may all have these effects. The presence of a chronic prostatitis due to either B. coli or to gonorrhœa is often a cause.

The treatment of these varieties of impotence consists in removal of the cause if possible.

The majority of impotents, however, exhibit none of the above causes, and appear perfectly normal physically, and these cases are divided into the two main groups of (*a*) psychical impotence ; (*b*) exhaustion impotence.

(*a*) *Psychical Impotence.* This nearly always takes the form of an inability to obtain an erection. It is seen in many different forms : in the case of young and nervous men who from fear and anxiety lest they should fail become impotent on the night of their marriage ; in men who, though perfectly potent with some women, fail completely with others for whom they appear to have just as strong a desire ; in patients who cannot function properly if any of the usual contraceptive appliances are in use, and in the strange instances of patients who require the presence of certain fetiches, real or ideal, to enable them to perform satisfactorily. Indeed the whole subject of sexual perversions, fetiches, Sadism, Masochism, etc., on which volumes have been written, is intimately connected with psychical impotence. For further information reference must be made to special works on sexual psychopathology. Little can be done for these patients except by means of suggestion.

(*b*) *Exhaustion Impotence.* This condition may follow upon overuse of the sexual organs, and is less likely to occur after excess of normal intercourse than after such abnormal indulgences as masturbation and " coitus with withdrawal." After the orgasm of normal intercourse the congestion and vascularity of the sexual organs, especially of the prostate, uterus masculinus and posterior urethra rapidly and completely disappear. But in the somewhat incomplete orgasms to which other practices give rise, the parts are left congested, further sexual stimulation is therefore set up, further congestion follows, and a vicious circle is established which leads to chronic swelling and congestion of the parts concerned, and in time to exhaustion of the nervous mechanisms of erection and ejaculation, preceded by a hyperirritability. The condition comes on in stages—the first one, or stage of hyperirritability, taking the form usually of premature ejaculation, and this is followed later by short-lived erections, delayed ejaculation, and finally inability to get an erection at all.

An advanced stage of this condition is that known as *spermatorrhœa*, when the irritability is such that the sight or thought of a woman is enough to produce a flow of semen usually without any erection or orgasm.

Treatment. Much can be done to rectify this condition if the patient has the strength of mind to assist. Stimulants, such as strychnine, etc., are at first worse than useless. Absolute sexual rest must be enjoined for two or three months. He should be kept continuously on large doses of bromide (aspirin also being useful), and every possible form of sexual stimulation avoided. Thus not only must he have nothing to do with the opposite sex, and as far as possible not see them or speak to them, but he must eschew pornographic literature and stories, theatres, the gay sights of city streets, alcohol and smoking. Together with this he should lead an active country life, with exercise and cold baths.

After about three months of this rigid treatment function should be returning, and if he then is provided with small doses of strychnine and Easton's syrup, he will probably return to his labours like a giant refreshed.

Hæmospermia. It is not uncommon for men to discover that their semen is blood stained, and for this to give rise to a great deal of mental perturbation. Though this may be due to acute or tuberculous vesiculitis, in most cases it is simply the result of congestion of the sexual organs and possibly the rupture of a small vessel. The patient may be informed that the condition certainly will set itself right though it may take some months to do so, as the semen continues to contain old brownish blood in it for some little time. Cases occasionally occur in which during or after copulation large quantities of blood pour out of the male urethra, as a result of intense congestion or the rupture of a vein. Urethroscopy and cystoscopy usually show nothing abnormal in these men.

CHAPTER XXII

THE SURGERY OF INJURIES AND DISEASES OF THE FEMALE GENITALIA

In the subjoined chapter some attempt is made to deal succinctly with those conditions of both the internal and external female genitalia which may come under the care of the surgeon either from their urgency, their accidental discovery at operation, or their diagnosis being confused with some allied pelvic condition. A full description of all the diseases peculiar to women, and a discussion of their pathology, is out of place in a text-book of general surgery, and for a fuller study of this subject the reader is referred to standard text-books on Gynæcology. The emergency conditions are dealt with together at the end of the chapter.

CONGENITAL ABNORMALITIES

Only those affecting the external genitalia are likely to be dealt with by the practitioner, and these are uncommon.

Fusion of the labia, absence of the vagina, and such allied conditions are more likely to be a sign that the child is a male with marked epi- or hypospadias (p. 893), and a guarded opinion as to sex should be given.

Occasionally the rectum or colon opens into the vagina, and usually imperforate anus coexists.

Persistence of a complete hymen will give rise to no signs until after puberty, when the absence of any external manifestation of menstruation probably will lead to examination. The retained blood causes the membrane to bulge down between the labia, and to present as a smooth rounded swelling of a deep purple colour. In neglected cases the whole vagina becomes enormously distended, sometimes with several years' retained menses (*hæmatocolpos*), and can be felt as a hard, rounded mass on abdominal examination; this may be mistaken for a pregnancy, unless the uterus can be felt perched above it, and the vulval condition is observed. The distended vagina, of course, can be felt on rectal examination.

The *treatment* consists in dividing the hymen by a crucial incision and gently washing out the remains of the dark tarry blood which escapes.

Douching should be continued daily for some days.

Bifid uterus, double vagina and other allied deformities are of more interest to the embryologist than to the surgeon, who, however, occasionally may meet the conditions at operation, when, unless their possibility be remembered, they form a puzzling problem. Rarely torsion of one horn of a bicornuate uterus occurs.

In the female the descent of the ovary towards the groin is arrested by the fused Mullerian ducts, and so the organ remains just below the pelvic brim and behind the Fallopian tube. The lower part of the gubernaculum persists as the round ligament of the uterus, and not infrequently drags down a process of peritoneum (the canal of Nück) into the inguinal canal and labium majus; occasionally the ovary may be pulled down into the inguinal region on one or both sides.

If the canal of Nück remains patent throughout its course, a *congenital inguinal hernia* will result, which not infrequently may contain the ovary. If the sac remains patent below, but the neck is obliterated, distension with serous fluid gives rise to an ovoid, translucent swelling in the inguinal region, which has no expansile impulse on coughing and cannot be reduced into the abdomen. This is a **hydrocele of the canal of Nück** and it should be excised. The condition is usually seen in small girls.

INJURIES OF THE GENITALIA

These are nearly always confined to the labia and vulva, and may result from cuts, kicks, violent coitus, or the attempted introduction of foreign bodies, usually with the object of procuring abortion.

If the injury is of the vulva its nature will be obvious, and should the skin or mucosa be divided hæmorrhage is free, but of a venous character. Large bruises and hæmatomata occur, and this is especially the case if varicose veins of the labia are present. Care must be taken in the case of *penetrating wounds* to ascertain that no damage has occurred to the bladder, rectum or peritoneum, especially that above the vaginal vault at the posterior fornix, *i.e.*, in the floor of the pouch of Douglas. This is very liable to be damaged in the passage of a straight instrument, such as a knitting needle in attempting abortion, and this will be understood readily when it is remembered that the uterus is fixed in to the upper end of the anterior vaginal wall, and therefore sharply angled forward to the long axis of the vagina. In all cases of vaginal hæmorrhage in a woman under forty-five a speculum should be passed and the posterior fornix examined as well as the cervix, for even though a miscarriage be present, it may be associated with wounding of the vaginal vault if it has been "induced."

Treatment. In the case of vulval wounds this consists in cleansing and suture, after which the patient is confined to bed for ten days, and the area gently douched with weak sodium bicarbonate twice a day.

In penetrating wounds, if the speculum shows injury to the vaginal vault, immediate laparotomy must be performed, the peritoneum be cleansed carefully with saline, and the wound edges excised and sutured in early cases. Should pelvic peritonitis be present some surgeons prefer to drain through the wound into the vagina. Injuries of the bladder and rectum must be dealt with promptly and suitably (Chapters XIX., XX.).

Rupture of the "perineum," in the gynæcological sense, involves tearing of the septum between the vagina and rectum, and seldom occurs apart from the overstretching of this region which occurs during child-birth. It varies in extent from a superficial tear of the "fourchette" to a complete severance of the whole of the lower end of the septum, in which the external sphincter ani is torn across, and the rectal and vaginal walls divided (*complete ruptured perineum*). In this last case the patient is, of course, incontinent of fæces, and in old-standing, neglected cases of complete rupture there is for all practical purposes a return to the primitive cloacal condition.

Treatment. The condition is obvious; it should be looked for after every "labour," and any tear present be sutured immediately. In complete rupture care must be taken to join the torn ends of the sphincter ani with one or two mattress sutures of catgut, and then to repair the rectal, anal and vaginal walls with single stitches of the same material. Deep sutures must be passed through the perineal tissues to approximate the structures in the upper part of the wound, or else the "perineum will break down" if only the skin edges are drawn together.

In old-standing cases, especially if the anterior rectal wall (*rectocele*) or posterior bladder wall (*cystocele*) are sagging into the vulva, or if uterine prolapse or incontinence be present, plastic operations must be undertaken for the cure of these conditions. The reader is referred to a gynæcological text-book for a description of *colporrhaphy* and *colpoperineorrhaphy.*

Vaginal hæmorrhage occurs monthly from puberty to the menopause as a physiological process, *menstruation*, the bleeding usually lasting three to five days and often being preceded or accompanied by pelvic pain (*dysmenorrhœa*) and some general constitutional disturbance.

Apart from this, hæmorrhage in young women occurs usually from *miscarriage* or childbirth trauma, septicæmia or severe blood diseases; it will occur after both pregnancy, labour or miscarriage as a normal process, and often persists as an abnormal one if products of conception (placenta or membranes) be retained.

In women over forty carcinoma of the cervix uteri, flooding of the menopause and fibrosis or fibromyoma of the uterus are to be suspected.

Treatment. In all cases of vaginal hæmorrhage a digital and visual examination of the vagina and cervix must be carried out, and the case referred to a competent gynæcologist for treatment.

It is well to be sure the bleeding is from the vagina and not from the urethra or rectum.

Watery discharge from the vagina is usually associated in young women with abnormal pregnancy, and in old women with carcinoma of the cervix or body of the uterus. Once it has been ascertained that the discharge is vaginal and not due to urinary incontinence, the case must be referred promptly to a gynæcologist.

Amenorrhœa, absence of the normal menstrual flow, occurs normally before puberty and after the menopause, and between these periods during pregnancy. Apart from this it may be of pathological occurrence in severe anæmias, wasting diseases, advanced carcinoma, diabetes, etc., while in some few cases its place may be taken by monthly issue of blood from some other mucous surface, such as the nose, a condition known as *vicarious menstruation.*

Rupture of the uterus generally results from continued tonic spasm in obstructed labour, but may occur from blows or falls during pregnancy or during intra-uterine operations. Usually uterine contents and blood escape into the peritoneal cavity and peritonitis often supervenes; occasionally, however, coils of small bowel prolapse and may hang out from the vagina. Owing to pressure they are thin and empty, and may become gangrenous; a loop of prolapsed bowel has on occasions been mistaken for a prolapsed umbilical cord, and even ligated and divided.

There is usually intense hypogastric pain and tenderness and some vaginal hæmorrhage, while the abdominal mass may be appreciably smaller than before. The general signs of collapse are often marked.

Treatment consists in immediate laparotomy and cleansing of the peritoneum, abnormal contents being removed from the abdominal cavity and prolapsed bowel replaced and, if necessary, resected, with subsequent end-to-end anastomosis. Vertical slits in the uterine wall may be sutured with hæmostatic mattress stitches passing deeply, but if the organ is much disrupted or sepsis present a subtotal hysterectomy should be performed.

AFFECTIONS OF THE VULVA, VAGINA AND CERVIX UTERI

Acute infections of the vulva are almost always gonococcal, and usually met with in young women who are recently married or habitual prostitutes; occasionally direct-contact epidemics are met with in girls' schools, and may assume alarming proportions. The vagina is generally also infected, but owing to its thicker and less vascular walls shows but little alteration from normal, and, indeed, its rather acid secretion may preserve its upper regions from invasion where infection is primarily vulval.

The uterine cervix is generally infected, and presents as a hot, red, velvety swelling projecting into the anterior vaginal fornix. In acute infection it is tender and secretes pus, while if chronically inflamed the cervix appears plum-coloured and secretes a copious flaky, mucopurulent discharge.

Gonorrhœal vulvovaginitis follows infected coitus, or rarely may be acquired from the use of an infected towel or closet seat. As described in Ch. VI., Vol. I., where the condition is fully discussed, the signs are much milder than in acute gonorrhœa in the male, and all too liable to escape notice until widespread complications have occurred.

Persistence of the infection in the uterine cervix and vaginal fornices is common in those cases where the infection has been neglected, so that a *chronic vulvovaginitis* is frequent in such cases. The chief sign is a flaky, mucopurulent discharge which stains and stiffens the linen, being due to the uterine and cervical infection; treatment, therefore, needs to be directed primarily to the cervical mucosa and canal in these cases. There is usually much anæmia and chronic constipation, so that unless a swab of the cervical secretion is taken and examined for gonococci the case may be diagnosed as one of leucorrhœa, though in the gonorrhœal vulvovaginitis the discharge has usually a distinct yellowish tinge which is absent in the milky-white fluid seen in simple leucorrhœa.

Treatment. This, as already mentioned in Ch. VI., Vol. I., consists in baths and warm douches in the acute stage; while should the disease become chronic the uterine cervix and cervical canal must be swabbed daily with silver nitrate, the vagina douched and packed with antiseptic plugging.

Bartholin's Abscess. Infection of Bartholin's glands, which lie on either side of the vagina just above the hymen, is a comparatively common complication of acute and chronic vulvovaginitis, and seldom seen apart from gonorrhœa.

In the early stages tenderness, often first noticed on coitus, exists on one or other side of the vaginal orifice, which on examination is seen to be swollen, red and tender on the affected side, while the mucosa appears dry. Later the signs increase in severity and marked œdema is present, while the onset of throbbing pain and the detection of fluctuation indicates that suppuration has occurred. At this stage pressure may squeeze creamy pus from the gland duct, the orifice of which lies just beneath the hymen. If the duct becomes blocked the abscess increases rapidly in size and bulges into the vaginal orifice (acute abscess). Should the duct remain patent, usually it will drain the gland and the condition temporarily subsides; subsequent blockage often causes frequent, if mild, relapses, and the condition passes into one of either chronic abscess or chronic infection of the gland. Either of these is a fruitful and frequent source of persistence of gonorrhœal vulvovaginitis in women, where usually both glands are involved.

Treatment. In the acute stage this consists in hot douching, with incision and drainage if an abscess forms. In this case the gland mucosa is generally destroyed and a cure results. In chronic cases the gland and its duct must be excised under a general anæsthetic ; this is usually easy, as the walls are thickened. It is best only lightly to suture the incision in the vaginal wall, as infection of the wound is probable.

Rarely a **gangrenous vulvovaginitis** (**noma**) is seen, usually in young girls, when it is due to diphtheritic or streptococcal infections. Such cases are frequently accompanied by extensive gangrene and sloughing of the external genitalia, which result in much scarring and deformity should the child survive, which is uncommon. The condition is fully dealt with in Ch. VII., Vol. I.

Varicose veins of the labia majora and vulva are not often met with, apart from the latter months of pregnancy, when they are not uncommon in patients with varices of the lower limbs.

One or more transverse veins may be enlarged across the anterior ends of the labia majora, or many masses of distended purple veins may occupy the entire vulva in severe cases.

There is usually some œdema and severe pain, much aggravated by walking, while piles are almost invariably present, as also are varicose veins in the legs. Such veins may rupture during the end of pregnancy, or at parturition, when severe and sometimes fatal hæmorrhage will occur.

Treatment consists in making the patient rest in the recumbent position as much as possible, and examining the pelvis for the presence of abnormal neoplasms or fœtal positions, which may cause venous obstruction. These, if present, will need removal or correction. Rapid amelioration follows delivery. Should rupture occur the veins may need ligature. Injection of 5 per cent. sodium morrhuate often cures, quinine is contra-indicated in pregnancy.

Eczema of the vulva occurs in diabetes and chronic urinary incontinence, which latter condition often accompanies cystocele and uterine prolapse.

Prurigo is common in obese women, the skin being red, shiny, and often sodden.

In both conditions extreme cleanliness and regular powdering will much improve the local condition, while, if pruritus be present, regular application of icthyol ointment or lotio creolin usually will give relief.

Tuberculosis may occur occasionally, usually as a **lupus**, when extensive ulceration and scarring occur around the vulva. Adhesions between the labia and at the vaginal orifice are common, while the general infiltration may involve the urethra and cause great difficulty in micturition. In such cases ischiorectal abscess and fistula-in-ano frequently coexist.

The *diagnosis* is by no means easy, as syphilitic lesions and carcinoma, both of which are more common, closely simulate this condition. Removal of a piece for microscopy should be done in all cases, when typical giant cells will be seen if tuberculosis be present.

Treatment is most unsatisfactory. Excision may be attempted in early cases, but the patient seldom comes under observation till the disease is extensive, and then X-ray and radium treatment must be resorted to, generally with disappointing results.

Syphilis. (*a*) *Primary chancre* is common in the vulva and on the cervix uteri, where it often escapes notice, but is seldom seen on the vaginal wall. As in most infections, the vagina escapes, due partly to the thick resistant lining mucosa, and partly to the acid secretion destroying the micro-organisms. There is less induration than in the male in the majority of cases, but in all vulval chancres the typical discrete, painless enlargement of the inguinal lymph nodes is present. Where the cervix uteri is the seat of the sore, glandular enlargement will of course be intrapelvic and so escape notice.

(*b*) *Secondary ulceration* is often present in the vulva, where typical snail-track ulcers may be seen if they are looked for.

Condylomata are by no means uncommon, especially in women of dirty habits, when they often extend back around the anus and may be mistaken for piles.

(*c*) *Gummata* also occur in the vulva, occasionally as localised masses which break down and ulcerate, but more often in neglected cases as a diffuse infiltration, when the whole perineum is swollen and ulcerated. Later, extensive scarring and disfiguration follows, a condition which is often the precursor of epithelioma vulvæ and esthiomène, a closely allied condition described as occurring in Parisian harlots.

The treatment of syphilis in no way differs from that described in Ch. VI., Vol. I.

Kraurosis vulvæ is a rare condition where extensive scarring and distortion occurs in old women. It is not syphilitic in origin, but frequently becomes carcinomatous.

Œdema of the vulva occurs during the latter months of pregnancy, but if marked should lead to a suspicion of renal disease or the possibility of eclampsia in the mother. It also occurs in prolonged or obstructed labour. Apart from these, œdema is seen in extensive uterine or pelvic carcinoma, advanced renal or cardiac disease (when œdema of the lower limbs co-exists), and occasionally in acute trauma or infectious conditions.

Neoplasms of the Vulva. *Simple tumours*, such as fibromata, papillomata and angiomata, are by no means uncommon, and often markedly pedunculated. They usually occur on the outer aspect of the labia majora.

Venereal warts, seen around and in the vulva in cases of chronic gonorrhœa, are to be regarded as septic granulation tissue and not true neoplasms. They usually disappear with treatment of the infection, but may be snipped away or cauterised.

Epithelioma of the vulva is a squamous-celled carcinoma and usually seen in elderly women, in whom it may start either (1) in the skin on the outer surface of the labium majus, when it usually presents as a hard, warty growth ; (2) on the inner aspect of the labium majus or around the fourchette, when it occurs as an indurated fissure ; (3) as a diffuse infiltration of the entire vulva, usually commencing in one labium minus near the anterior end and occurring in youngish women. The whole vulva appears infiltrated and œdematous, and the condition is often confused with tuberculosis or tertiary syphilis.

In all three varieties ulceration ultimately occurs, the ulcer being of the typical indurated malignant type and increasing very slowly in size, unless, as is frequent, secondary septic infection is superadded. Glandular involvement occurs early and typically in the inner inguinal lymph nodes. There is usually some irritation and serosanious discharge from the vulva. In the later stages vesico-rectal fistulæ generally occur.

The *treatment* consists in free excision, together with the inguinal nodes, in one mass. Such an operation is only practicable in early cases, and is even then followed by extensive scarring, which if necessary may be removed by subsequent grafting or plastic operations. In the later stages X-ray treatment offers a faint chance of amelioration.

Neoplasms of the Vagina. The vagina is rarely the seat of new growths, though occasionally a submucous fibroma may be met with or an epithelioma start in the vaginal wall. Cysts in connection with Gärtner's duct may occur along the lateral walls, and must not be confused with chronic Bartholin's abscess.

Neoplasms of the Uterine Cervix. Simple tumours (*cervical polypi*) not infrequently occur in connection with the glands of the cervical canal and may be regarded as adenomata in most cases. They present as semitransparent polypoid masses and can be easily avulsed. The discharge caused by their presence is mucous and glairy.

The gynæcologist recognises as cervical or uterine polypi certain other masses which may protrude from the uterine body through a dilated cervical canal. In this case the pedicle can be felt passing up the distended canal, between the lips of the cervix. Extruded submucous fibromyomata, adenomyomata, carcinomata or sarcomata, and, in some cases, retained products of conception, may give rise therefore to errors in diagnosis if a careful examination be not made, while the discharge is generally sanious or purulent and contains portions of the tumour, which is frequently ulcerating or sloughing.

Carcinoma of the cervix may start :—

(1) In the vaginal surface, when a squamous-celled carcinoma results ; or

(2) In the glands of the cervical canal, when the neoplasm is of the columnar-celled variety. Both types usually occur in multiparæ over fifty years of age.

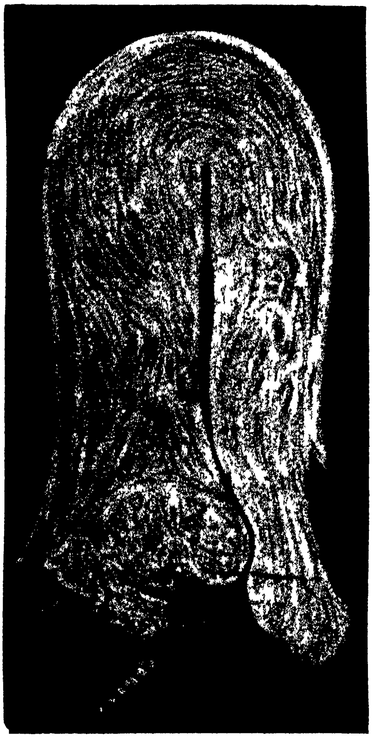


FIG. 335. Ulcerating carcinoma of the cervix uteri.

In either case the signs in the early stages are few, but the cervix can be felt enlarged and has a characteristic rubbery feel. Later, ulceration and sloughing occur, when a free sanious discharge appears and hæmorrhages are not uncommon. The growth soon invades the broad ligaments and pelvic cellular tissue, so that the uterus becomes fixed.

It cannot be impressed too strongly on the reader that a sanious vaginal discharge in a woman about the menopause calls for vaginal examination, as carcinoma must always be suspected, especially in multiparæ. The case must be referred to a gynæcologist for treatment, which consists in hysterectomy, together with excision of the pelvic lymph nodes (Wertheim's operation).

Radium Treatment (transabdominal). In advanced cases much benefit often accrues from the implantation of radium needles. The first thing to be done is to make a utero-vaginal application in the usual way; by this the lesions of the cervix are apparently cured. Two to two and a half months later, if the ligaments are suspected to be invaded, a laparotomy is performed and needles and tubes are placed in the connective tissue around the cervix.

Cervical erosion is a condition closely allied to columnar-celled carcinoma, and often passing on to it. The glands of the cervical canal enlarge and burst, and the columnar epithelium grows out over the squamous epithelium of the vaginal surface. This is replaced, and around the canal the abnormal mucosa forms a soft, velvety area which bleeds readily on examination. In many cases the mucosa invades the cervix deeply.

The case can be treated safely only as a carcinoma.

Vaginal Fistulæ. (1) Occasionally, either after operations or ulceration due to a calculus, the ureter communicates by a fistulous track with the lateral vaginal fornix above which it passes. In such cases urine escapes from the vagina, and should infection occur phosphates may be deposited forming a vaginal concretion.

(2) After prolonged labour the anterior vaginal wall may slough and a *vesicovaginal fistula* develop, the opening usually being of large size. It may occur also from the ulceration of a carcinoma.

(3) *Rectovaginal fistula* may be congenital, but usually follows perforation of the septum by a carcinoma of the rectum in old women or sloughing after labour. The condition is usually obvious, though occasionally the foul discharge from a neglected pessary may give rise to a suspicion that fistula exists.

Treatment is generally unsatisfactory; plastic operations should be undertaken but are seldom successful, and must never be attempted except by an expert surgeon. In ureteric fistula it may be advisable to perform nephrectomy if it has been ascertained definitely which ureter is involved and that the other kidney and ureter are normal. In rectovaginal fistulæ the performance of a colostomy often gives relief.

AFFECTIONS OF THE BODY OF THE UTERUS

Two types of uterine affection may confront the surgeon: (A) displacements, and (B) enlargements.

(A) *Displacements.* On vaginal and bimanual examination the uterus can be detected as an ovoid flask-shaped organ about 3 inches long lying in an anteverted position above and behind the urinary bladder. The cervix projects backwards as a firm, rounded knob into the anterior wall of the vagina, and moves readily in all directions when pressed on by the examining finger, such movement being accompanied by corresponding mobility of the body. Normally the uterine fundus cannot be felt above the pubes on abdominal examination, *i.e.*, the uterus is a pelvic viscus.

(1) **Retroversion.** Not infrequently the uterine body may assume an upright position or tilt backwards into the rectovaginal pouch (of Douglas), and in such a case sacral and pelvic pain may result. The condition, however, often exists when no such symptoms are present.

In such cases, usually women who have had children and often pelvic inflammation, the cervix is abnormally high up, and can be felt to be tilted forwards. In cases where adhesions exist in the pouch of Douglas manipulation from the vagina or bimanually will fail to secure reposition, but usually such a manœuvre is successful. The replaced organ may be kept in position if necessary by the use of a Hodge or ring pessary. Should manipulation fail to secure reposition of the organ a gynæcologist should be consulted.

(2) **Uterine prolapse** is often a sequel of retroversion, and never occurs unless this is present in some degree. The condition is one affecting women who have borne many children and in whom the pelvic diaphragm is much weakened; the tendency to prolapse is increased by the presence of ruptured perineum. The amount of prolapse varies considerably from the slightest form, where there is sagging of the anterior (cystocele) or posterior (rectocele) vaginal walls, to complete eversion of the vagina, which hangs down between the thighs, with the cervix uteri presenting at its lowest point (procidentia). In the more severe cases there is often considerable hypertrophy of the supra-vaginal portion of the uterine cervix, a condition which, if severe, calls for partial removal of the neck.

Treatment. In the early stages much may be done by the use of a suitable pessary, and still better results achieved if it be realised that generalised visceroptosis exists and an abdominal belt is prescribed. The reverse also holds true, and far too many doctors prescribe abdominal belts for visceroptosis with disappointing results, because they forget that the coexisting uterine prolapse needs shoring up from below.

In more advanced cases a gynæcologist must be consulted, as some form of colpoperineorrhaphy, ventrofixation, or sling operation to secure anteflexion, will be required, and these must not be attempted by the tyro.

(B) *Enlargements of the Uterus.* Generalised enlargement of the uterine body may be diagnosed by the detection of a globular mass rising above the pubes and persisting after the bladder has been emptied by a catheter. Such enlargement is usually physiological, and **pregnancy** must always be excluded before any other diagnosis is made.

In regard to cyesis, it cannot be impressed too strongly on the reader that pregnancy must never be terminated prematurely without first obtaining a second opinion, and, if possible, that of a gynæcologist of repute.

When pregnancy has been excluded there remain other causes of uterine enlargement, and it must be determined whether the condition is due to: (i.) distension of the uterine cavity; (ii.) disease of the mucous membrane; or (iii.) disease of the wall of the uterus.

(i.) *Distension of the uterine cavity* nearly always results from a pathological state during pregnancy, or soon after, but is occasionally seen as the result of accumulation of secretion, usually infected, in a retroverted organ.

Hydramnios is a condition where excessive amniotic fluid is present during pregnancy; this may cause great discomfort and dyspnœa from pressure on the abdominal viscera and the diaphragm. The uterus is much larger than it should be for the alleged period of pregnancy and the fœtal heart sounds distant or absent. A gynæcologist should be consulted.

Hydatidiform mole is also met with in pregnancy, usually in the early months. The chorionic and placental villi become degenerate and cystic and multiply to form an enormous mass of bladder-like swellings, much resembling a bunch of white grapes. These occupy the amniotic and uterine cavity, project through the os uteri, and may invade and even penetrate the uterine wall, appearing in the peritoneal cavity. There is a blood-stained vaginal discharge in which the colourless cysts may be detected, giving the appearance of white currants in red currant jelly.

The condition is a serious one in view of the malignant tendency to penetrate the uterine wall, and to the development of chorion epithelioma. Treatment requires to be carried out by a skilled gynæcologist, and consists in complete removal of the mass and, if necessary, of the uterus.

Pyometra is usually seen in old women with a fibrotic retroverted uterus, but may occur after infection during labour, when it is met with during the puerperium. There is a foul, purulent vaginal discharge, varying in amount according to the position of the patient, who is usually sallow and ill and has a hectic temperature. On vaginal and bimanual examination the enlarged and tender uterus can be felt lying in the pouch of Douglas, and pus can be expressed.

The only satisfactory treatment is hysterectomy, but often, owing to the age of the patient, reposition, a pessary and douching are all that are advisable.

(ii.) *Enlargements due to disease of the mucosa* are never very marked.

Retained products of conception are closely incorporated with the mucous membrane; they consist of pieces of the placenta and membranes, and may be rarely the whole of the fœtal adnexa. In recent cases it is well to adopt no treatment beyond giving liquid extract of ergot, ♏x t.d.s., when the contraction of the still excitable uterine muscle often expels the retained tissue. Where infection exists, however, and in old-standing cases where the mass has fibrosed to a *fibrous polyp*, the os uteri must be dilated and the tissues removed by a blunt curette.

Acute infections usually occur during the early stages of the puerperium either from (*a*) infection during labour, when *puerperal septicæmia* often results, in which the uterus is hard and tender and little vaginal discharge (lochia) is present; or (*b*) infection of retained membranes, when *sapræmia* occurs, the uterus being bulky and the lochia profuse and foul. Sapræmia is fortunately the more common and less fatal condition; both are notifiable infectious diseases.

Treatment. In sapræmia this consists in douching out and gently removing the infected uterine contents, when improvement rapidly follows. In septicæmia a blood culture must be taken, and suitable antisera or vaccines given; no local treatment is advisable. The prognosis is very grave.

Chronic infection (chronic endometritis) sometimes follows infection after pregnancy, or may be due to chronic gonorrhœal endometritis; more often, however, no obvious infection is present and the condition may be regarded as due to abnormal persistence of the hypertrophic changes in the endometrial mucosa, which occur in the normal menstrual cycle. Thus the glands in the majority of cases are elongated and assume a corkscrew appearance, while there is marked increase in the vascularity and connective tissue elements of the submucosa. In consequence the mucous membrane is thickened and velvety, and may assume a polypoid appearance in places. Severe and frequently recurring hæmorrhages are a constant clinical manifestation, and from their sudden onset gain the name of "floodings." The condition may be met with in young women, where it is a frequent cause of sterility, and about the time of the menopause, when there is a distinct tendency for the glands to burrow among the muscle of the wall and give rise to adenomyoma or adenocarcinoma.

Treatment. This consists in dilatation of the cervical canal and careful curetting of the mucosa, especial care being devoted to the upper angles. Curettings should always be examined microscopically, especial inspection being made for any evidence of malignancy. Application of radium often will effect a cure.

Polypi. Certain tumours of the mucosa and of the uterine wall may project into the cavity and, becoming pedunculated, distend this and even hang down through the dilated os uteri into the vagina.

Such are fibrous polypi (retained placenta), adenomatous polypi, mucous polypi (which arise usually in the cervical canal), fibromyomata, and occasionally multiple masses of sarcoma, chorion-epithelioma or hydatidiform mole. Should infection occur the mass may ulcerate or even slough, and so occasionally effect a cure spontaneously.

Neoplasms of the uterine mucosa are rarely simple, though occasionally an *adenoma*, or more often an *adenomyoma*, may be met with.

Of malignant neoplasms carcinoma is by far the most frequent, and is, of course, columnar-celled in type, as the uterine mucosa is of the columnar variety. Carcinoma starting in the cervical canal has been discussed already on p. 967, but it may be well to note that this form of the disease is commonly met with in multiparous women over thirty-five years of age.

Carcinoma of the body of the uterus, though much less frequently seen than in the cervix, is, if anything, more common in nulliparæ, and often is seen in single women at or after the period of the menopause. The growth spreads rapidly over the mucosa and invades the wall, but owing to the thickness of this it is not early disseminated, and so has a better prognosis than cervical cancer.

Clinically there is a generalised, slight and fairly rapid enlargement of the uterus, while hæmorrhage is constantly present, though varying in amount. Pyometra may be associated, and as the ulcerating mass becomes infected the discharge is often offensive and the temperature raised. Pain is a constant and early symptom, being periodic and tending to recur at the same hour each day. When the growth escapes from the uterine wall it invades the cellular tissues of the broad ligament, the peritoneum and surrounding viscera, but this occurs far later than is the case with carcinoma of the cervix ; subsequent to such invasion fixation, ascites and fistulæ will develop. As in the case of cervical carcinoma, the pelvic lymph nodes are involved, but this is difficult to detect on clinical examination. In advanced cases the inguinal lymph nodes may become involved, invasion taking place by means of the lymphatics along the round ligament.

Treatment. As in carcinoma of the cervix, this consists in panhysterectomy, together with excision of the pelvic lymph nodes and cellular tissue (Wertheim's operation), care being taken not to damage the ureters and bladder.

Chorion epithelioma (Deciduoma malignum) is an intensely malignant carcinoma commencing in the chorionic villi during pregnancy, usually in the later months or immediately after delivery. Two types of cells, corresponding to the epithelium (polygonal cells) and syncytium (masses of multinucleate protoplasm), occur. The growth rapidly eats through the uterine wall, and metastases early appear in distant viscera, notably the lungs. The condition is closely allied to, and often preceded by, hydatidiform mole. Plum-coloured metastases may be seen in the vaginal and vulval walls. Free hæmorrhage occurs from the growth and metastases, and the patient is very anæmic and wasted. Abortion usually occurs early, when, as in hydatidiform mole. degenerative changes are often present.

Treatment is seldom practicable or advisable ; but if the case has no apparent metastases, total hysterectomy should be carried out together with removal of both ovaries and Fallopian tubes.

(iii.) *Enlargements due to abnormal conditions of the uterine wall* may be of considerable size, and if, as is commonly the case, they are due to the presence of fibromyomata, are very often irregular in shape.

Fibrosis uteri (fibroid uterus) is a condition seen at or after the menopause, where the musculature of the uterine wall degenerates and is replaced by fibrous tissue among which lie numerous dilated veins. There is moderate uterine enlargement, and severe repeated floodings occur. Rarely sarcoma supervenes.

Treatment consists in application of radium through the cervix, or if this fails to arrest hæmorrhage, subtotal hysterectomy must be performed.

Fibromyomata (uterine fibroids) are simple neoplasms which occur with comparative commonness in the uterine wall, and which, unless of some size, give rise to no abnormal signs. They are usually multiple and may vary in size from a pea to a cocoanut, or even larger. The tumours are met with more commonly in unmarried women over thirty; should they be present they often prevent conception from occurring.

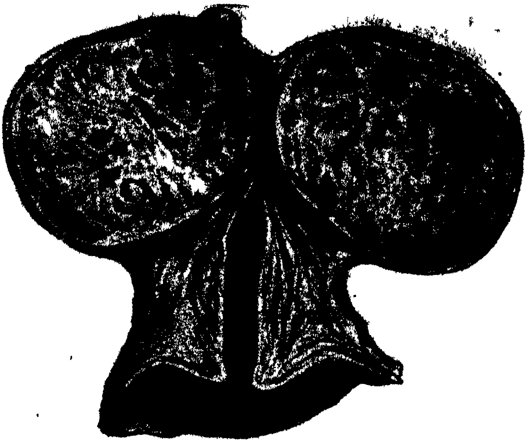


FIG. 336. Uterine fibromyoma. Note small subserous fibroid on the fundus.

In situation they vary; thus if growing in the thickness of the uterine wall they are said to be *interstitial*, while if near the peritoneal or mucous surfaces they are called *subserous* and *submucous* respectively. These latter varieties are prone to become pedunculated, projecting into the peritoneal and uterine cavities (p. 971), and may necrose, following torsion of their pedicle. Apart from this, all fibromyomata are liable to undergo degenerative changes (*necrobiosis* or *red degeneration*), which may result in sloughing, or may settle down and lead to calcification, while their avascularity renders them susceptible to infections, which may be from the uterine cavity, the bowel, or the blood stream. Occasionally sarcomatous changes occur.

Fibromyomata are encapsuled tumours, and consist of whorled masses of dense fibrous tissue, with a small and varying admixture of unstriped muscle tissue (Vol. I., Fig. 98); if necrobiotic, they are of a reddish colour and œdematous, and microscopically show marked disintegration and round-celled infiltration.

Clinically the uterus shows marked and often irregular nodular enlargement, the whole mass moving with the cervix uteri, which itself may be the seat of a fibroid. There is usually marked and irregular hæmorrhage (metrorrhagia), and excessive loss at the menstrual periods (menorrhagia). Pain, if present, is slight, though if large, the weight and bulk of the mass may cause discomfort and dysuria and constipation from pressure on surrounding viscera. A polypoid submucous fibroid often causes violent bearing-down pain, and if partly extruded, ulcerated and sloughing, may be mistaken for a carcinoma of the cervix. A cervical fibroid may cause obstruction during labour.

Treatment consists in removal of the submucous and subserous polypi, an easy matter, while large and solitary interstitial fibroids may be shelled out (myomectomy). Multiplicity of tumours calls for hysterectomy, an operation only to be undertaken by a competent surgeon, as it may be very difficult in these cases, especially where cervical tumours are present. Double salpingo-oophorectomy has been recommended to retard enlargement and diminish hæmorrhage, but has nothing to recommend it over hysterectomy.

Sarcoma of the uterus is uncommon and usually diagnosed as carcinoma of the body, which it closely resembles clinically. Microscopically, sarcoma may be round- or spindle-celled.

The treatment is as for carcinoma.

DISEASES OF THE FALLOPIAN TUBES AND OVARIES

Inasmuch as the free fimbriated end of the Fallopian tube is closely approximated to, and indeed partly surrounds, the ovary, it is natural that when there is any inflammatory condition the fimbriæ should adhere to the ovary, so that the two become fused into one mass. Moreover, in enlargements of the ovary, especially when this growth projects forwards between the layers of the broad ligament, from the posterior layer of which the ovary normally projects, the tube becomes stretched over and hard to distinguish from the

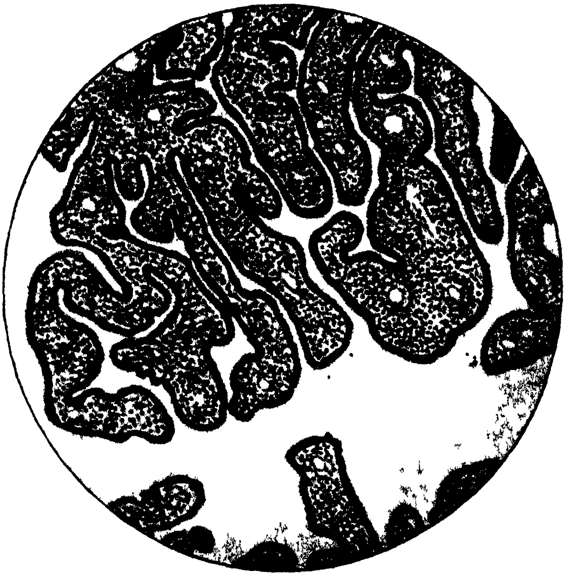


FIG. 337. Fimbriæ of the Fallopian tube, showing round-celled infiltration in early stages of inflammation. × 70.

tumour. Thus it will be seen that disease of the one viscus almost invariably involves the other.

It is well to remember that the ovary projects into the peritoneal cavity, being covered only by a layer of germinal epithelium (and no peritoneum), so that an ovum escapes into the peritoneal sac, and normally is directed by the ciliated epithelium of the fimbriæ into the adjacent ostium of the Fallopian tube, and then down the tube into the uterine cavity, where fertilisation occurs.

Sometimes, often owing to previous inflammation, the ovum may be arrested and fertilised (*a*) in the ovary itself; (*b*) in the Fallopian tube; or (*c*) in the peritoneal cavity, when an **ectopic gestation** occurs. This condition, though of great interest to the gynæcologist, only concerns the surgeon when, as is the case in ovarian and tubal pregnancy, lack of possibility of expansion causes premature termination of the pregnancy, with severe intraperitoneal bleeding (*ruptured ectopic gestation, tubal abortion*, p. 980).

Acute Salpingitis. Acute infection of the Fallopian tubes always results from ascending infection via the uterine cavity, and therefore is primarily an inflammation of the mucosa. The condition is generally seen in young women, but may occur in quite young girls.

(*a*) Puerperal infections are usually streptococcal, or more rarely staphylococcal, and occur a few days after delivery as the result of infection in the uterine cavity spreading to the tubes. The condition is often overlooked, as the local signs are masked by those of sapræmia or septicæmia.

(*b*) **Pneumococcal salpingitis** is usually seen in little girls, and is rapidly followed by the onset of pneumococcal peritonitis, which is generally fatal (Chapter XIII., p. 548). The tubal infection is transient and seldom diagnosed.

(*c*) **Gonococcal salpingitis** is by far the commonest acute infection, and is usually met with from ten days to three weeks after infection, as the result of direct upward extension from the vulva and cervix uteri; it may occur, however, at any time so long as cervical infection persists. The disease is particularly common in prostitutes, and unfortunately all too often seen in young married women, where it is the result of an uncured gleet in the husband. Sterility generally follows, owing to blockage of the tubal lumen by adhesions, while chronic pelvic pain, pyosalpinx, and abdominal adhesions frequently result, so that the unfortunate woman becomes a chronic invalid in many cases.

Pelvic and occasionally general peritonitis are usual accompaniments of the tubal infection, as the pus escapes through the abdominal ostium; these may be fatal, but much more often result in the formation of dense adhesions, with a tendency to stricture of the intestine (Chapter XVI., p. 667). Generalised septicæmia, with fasciitis and joint infections, are by no means uncommon.

Clinically there is acute pelvic pain, and a purulent or seropurulent vaginal discharge. Constipation is absolute, and the tongue furred and dirty. The patient feels ill, and the temperature and pulse are raised.

Vaginal or rectal examination will reveal nothing beyond a generalised tenderness, usually more marked on one side of the pelvis, but present on both.

Pelvic peritonitis rapidly supervenes, when the lower abdomen becomes rigid and tender, while in the later stages the matted and distended bowel gives rise to distension of the suprapubic region.

Micturition becomes painful, especially towards the end of the act, and retention is not uncommon. Vomiting may occur, but is neither an early nor a constant symptom.

Diagnosis. This may present considerable difficulty, especially in differentiating *acute appendicitis.* Usually, however, although one tube may be more affected, both are to some extent involved, while the tenderness is most marked just above the pubes. In addition, the hyperæsthesia observed over the mons veneris in appendicitis, resultant on reflex irritation of the ilio-hypogastric nerve, is absent in salpingitis, as is also the typical fæculent odour of the breath.

It must not be forgotten, however, that salpingitis may cause secondary appendicular involvement, and vice versâ.

Pyelitis and cystitis also may give rise to errors in diagnosis, but here the presence of B. coli or some allied organism in the urine should clear up any doubt.

Treatment. This consists in laparotomy, squeezing out the pus from the inflamed tubes, which should not be removed, and mopping out the pelvis with sterile plugs. The abdomen is then closed without drainage. The operation is invariably followed by amelioration of the patient's condition and loss of pain.

The older and more conservative treatment of waiting until a pyosalpinx developed before interfering has nothing to recommend it.

The bowels must be kept open and energetic measures resorted to for the cure of the vulvovaginitis, especial care being devoted to the os uteri and cervical canal (see Vol. I., Ch. VI.).

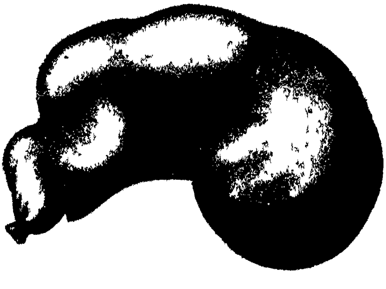


FIG. 338. Pyosalpinx.

Chronic salpingitis is nearly always the result of an acute infection, and while in some few cases the tubal lumen may be obliterated throughout by adhesions, in the vast majority this occurs only at the narrow uterine end. The inflamed fimbriæ become closely adherent to the ovary, and the abdominal ostium also becomes blocked in these cases. The accumulated pus and secretion dilate the tube, which assumes a characteristic flask-like shape, and the resulting abscess is known as a **pyosalpinx** ; this often infects the ovary, and the resulting common abscess cavity forms a **tubo-ovarian abscess.** In some very chronic and mild cases, usually pyogenic in origin and often puerperal, the purulent contents in the course of time disappear, and the resulting serous fluid which dilates the tube earns for this condition the name of **hydrosalpinx.** In all these conditions there are generally dense adhesions, binding the pelvic viscera together, often obliterating the pouch of Douglas, and holding the uterus retroverted.

Occasionally the abscess may discharge into the bowel, bladder or vagina, when a fistula results.

Clinically the condition may be present for years, subsequent to an acute, and maybe forgotten, attack of inflammation. The patients are sterile owing to blockage of the tubes, but menstruation is often free, and even excessive from the endometritis, and is usually accompanied by dysmenorrhœa of the congestive type. Chronic backache, pelvic pain and dragging are generally complained of, while a chronic vaginal discharge is the rule, though this is often slight in amount. Such patients are often anæmic, and tend to be querulous invalids. Pelvic examination shows a rounded mass on one or other and often both sides of the pelvis, tending to hang over and fill the pouch of Douglas. The uterus is usually retroverted and always fixed, often being displaced towards one side. The flask shape of the distended tube can be made out if surrounding adhesions are not too dense, and tenderness not too marked to permit this. Gonococci may be found in the vaginal discharge.

The *diagnosis* is usually easy if a pelvic examination be made. Occasionally a pelvic hæmatocele or ovarian dermoid may be mistaken for a tubal mass.

The *treatment* consists in laparotomy and removal of the infected tube and ovary, if necessary from both sides. The operation is often extremely difficult owing to the dense adhesions present, so that unless great care be exercised the bowel will be torn.

Tuberculous disease of the tubes and ovaries is unfortunately by no means rare in small girls and adolescents, and usually gives rise to a tuberculous peritonitis. In these cases it may be hard to differentiate the tubal abscesses (tuberculous pyosalpinx) from the matted bowel and omentum on rectal examination, but a thin serous vaginal discharge is generally present, and from this tubercle bacilli can be isolated.

The *treatment* consists in laparotomy and enucleation of the infected tubal masses, an operation only to be attempted by an expert surgeon. The results are usually very beneficial, both as regards the peritoneal and other foci of infection.

Ovarian neuralgia, usually associated with prolapse of the organ, which can be felt in the pouch of Douglas, is a condition calling for general tonic treatment, and no operation should be attempted without the advice of an experienced gynæcologist.

NEOPLASMS OF THE OVARIES AND TUBES

Ovarian fibroma is occasionally met with as a hard, painless, smooth and often bilateral tumour, calling for ovarian excision. Its development causes a premature menopause. Fibromyoma also occurs.

Carcinoma of ovary is a rare and again often bilateral condition seen generally in youngish women, where the first sign is often a severe intraperitoneal hæmorrhage, which leads to a diagnosis of ruptured ectopic gestation. If the carcinoma is confirmed microscopically, complete hysterectomy, with removal of both tubes and ovaries, is called for. Carcinoma of a columnar-celled type is sometimes seen in the Fallopian tube.

Sarcoma is a rare but rapidly disseminating and fatal condition. Diffuse metastases over the peritoneal cavity and ascites are marked, the fluid often containing blood.

Secondary carcinoma on the surface of the pelvic viscera may occur in carcinoma of any abdominal viscus and carcinoma of the breast.

Vascular and deeply maroon-coloured deposits, often multiple, are met with in chorion epithelioma.

Ovarian cysts are among the commonest afflictions of womankind, and in the majority of cases are congenital in origin. They often originate in childhood, but seldom cause trouble until adult life, and then only because of their size in the majority of cases.

The commonest type, the **multilocular cystadenoma,** occurs from abnormal development of Pflüger's tubules, the original ingrowths of the cœlomic epithelium from which the germinal cells develop. The cysts are usually unilateral, and consist of one large cyst from the inner wall of which a mass of smaller cysts, often communicating with each other, take origin. The whole presents a smooth, rounded mass, which varies in size from an orange to a mass occupying most of the abdominal cavity and containing several gallons of the pseudomucinous fluid with which such cysts are filled.

The lining membrane of the smaller cysts is a typical palisade columnar epithelium, but this in the larger cysts becomes flattened and almost squamous in type.

The cysts may occur at any age, but are usually met with from thirty to fifty years of age, when they frequently give rise to symptoms either from their bulk or from pressure on viscera. Large cysts, owing probably to mild attacks of infection from the bowel, become adherent to surrounding viscera.

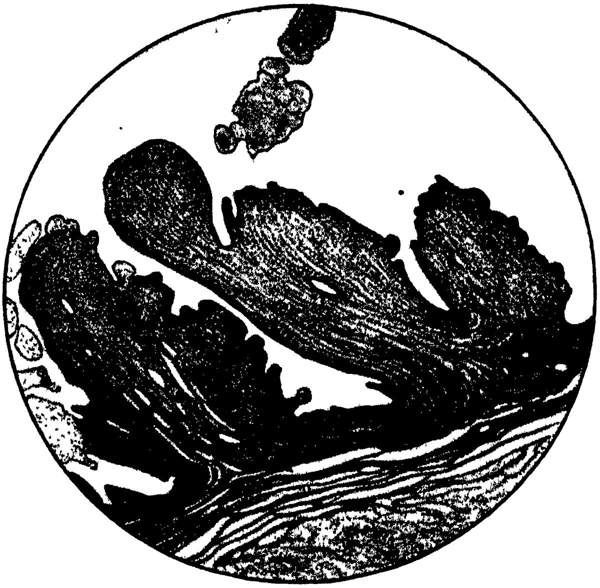


FIG. 339. Papilliferous processes on the surface of an ovarian fibroma. × 12.

Dermoid cysts may be regarded as true teratomatous tumours, and occur in quite young girls, though owing to their slow growth they seldom give rise to pressure symptoms before twenty-five to thirty years of age. Two varieties are met with—(1) unilocular, usually pedunculated, and containing clear fluid, with perhaps a few hairs springing from one point of the wall; (2) multilocular, sessile, and tending to burrow into the broad ligament. These are not so common, and usually contain thick, fatty material, and have all varieties of tissue growing from the inner wall, hair, teeth, and even mammæ or rudimentary limbs being met with. Such teratomata not infrequently undergo malignant changes.

Follicular cysts are small cysts occurring in connection with abnormal Gräffian follicles, and are classified as blood cysts, lutein cysts and serous cysts, according to their contents. They seldom reach a large size, about that of a chestnut, but the rupture of one of these in the right ovary, especially a blood cyst, may produce a train of symptoms and signs strongly suggestive of acute appendicitis.

Papilliferous cysts occur not infrequently and may be (1) *simple*, due to invagination and overgrowth of the epithelial lining of any of the above cysts, most commonly cystadenomata, or (2) *malignant*, when they may be regarded as carcinomatous. In these the proliferating epithelium not only completely fills and distends the cyst cavity, but invades and grows through the cyst wall, forming papilliferous masses on its peritoneal surface. In addition, these masses appear on all the viscera and the parietal peritoneum, and give rise to ascites, thereby closely resembling in signs malignant ovarian neoplasms, of which they probably represent a degenerative cystic variety.

Parovarian cysts arise in the mesovarium from the vestigial remnants of the organ of Rosenmuller, parovarium, etc., and form a cystic mass between the layers of the broad ligament, over which the Fallopian tube is tightly stretched. Such cysts are met with in young women, are often of some size, and cause a certain amount of immobility of the uterus, which is displaced away from them. They are frequently confused on pelvic examination with a multilocular dermoid or a chronic pyosalpinx. In this latter the uterus is drawn towards the mass.

Clinically all these cysts give rise to no symptoms (except the malignant cysts, where ascites develops) until they reach such a size that their bulk causes great inconvenience and abdominal enlargement, which may be mistaken for ascites.

In some few cases, especially with smallish pedunculated cysts, torsion (p. 981) is liable to occur, while occasionally rupture may follow trauma. Attacks of inflammation are liable to occur, which lead to subsequent adhesions.

Examination of the abdomen will reveal the presence of a more or less tense, rounded swelling, freely mobile in the case of small cysts, but usually adherent in the case of large ones. Such swellings have a convex upper margin, and if against the abdominal wall will be dull on percussion and may fluctuate. Pelvic examination probably will show the uterus to be normal in size, and not attached to the cystic swelling. In the case of large adherent cysts, however, this may not be the case, and then they are very difficult to diagnose from fibromyomata of the uterus. The two conditions not infrequently coexist.

Diagnosis. It is out of place in a text-book of surgery to enter into the differential diagnosis between the various types of ovarian cyst, but it is well to consider briefly other conditions with which they may be confused. Of these the most common is *ascites*, for the generalised form of which only very large, lax cysts are likely to be mistaken ; here the resemblance is great, but the absence of any obvious cause for ascites should excite suspicion of an ovarian cyst, especially in women under twenty-five, while resonance in the flanks, epigastrium and iliac fossæ and no shifting dulness may be taken as strong evidence that no free fluid is present in the peritoneal cavity. The localised (encysted) form of ascites met with in tuberculous and occasionally carcinomatous peritonitis presents grave difficulties, and often the diagnosis can be established only at operation. *Omental and mesenteric cysts* are very rare, but may cause trouble in diagnosis if present. *Hydronephrosis*, especially in a mobile kidney, is very likely to be called an ovarian cyst.

Pregnancy, if intrauterine, should never be confused with an ovarian cyst ;

if intraperitoneal, it may cause error unless the other signs of cyesis be elicited.

Fibromyomata also will cause difficulty if the cysts are adherent to the uterus, notably in the case of parovarian and multilocular dermoids, which have burrowed in the broad ligament. In these cases fluctuation may be felt in the cysts, while fibroids are unlikely below the age of thirty-five. In many cases errors in diagnosis occur.

The *treatment* consists in laparotomy and removal of the cyst. This operation (ovariotomy), which entails ligature and division of the pedicle (stretched mesovarium), will be very simple in the case of mobile pedunculated cysts, which if large can be emptied with a trocar and cannula to allow of their eventration. In those cases where adhesions exist, or where the cyst lies between the layers of the broad ligament, the operation is far from easy, and should never be attempted except by an experienced surgeon.

THE SURGICAL EMERGENCIES OF GYNÆCOLOGY

1. **In Connection with Pregnancy.** (*a*) **Incarceration of a Retroverted Uterus.** Should pregnancy occur in a retroverted uterus, this usually corrects its position, but occasionally the malposition persists. In such a case, about the third month of pregnancy, the enlarged uterus occupies all the pelvis, and the fundus being caught in the sacral hollow cannot rise into the abdomen. Pressure on abdominal viscera with retention of urine and obstinate constipation result and call attention to the condition, which often terminates spontaneously in abortion. Manipulation with a view to digital replacement of the uterus, after emptying the bladder, is called for urgently.

(*b*) **Concealed, accidental hæmorrhage** may occur into the uterus during the latter months of pregnancy. Following a fall or blow, the patient becomes intensely collapsed, and shows all the signs of an internal severe hæmorrhage; at the same time there is agonising abdominal pain and the uterus can be felt to be abnormally large, tense, hard and tender. Immediate laparotomy and Cæsarian section, followed in many cases by subtotal hysterectomy, offer the best chance of saving the lives of mother and child.

(*c*) **Central placenta prævia** may cause excessive and fatal hæmorrhage during labour, as the sinuses are torn by the expanding lower uterine segment.

The *treatment* consists in tearing through the placental tissue, after dilating the os uteri if necessary, grasping a fœtal leg and pulling it down so as to plug the os and lower part of the uterus ; in order to do this traction must be maintained on the leg. A gynæcologist must be sent for meanwhile.

(*d*) **Obstructed labour** may result from impaction of a brow , transverse, or shoulder presentation in the pelvic outlet, or from contraction of the pelvis preventing the passage of a normally presenting child. Rarely cervical fibroids or parovarian or multilocular dermoid cysts in the broad ligament may obstruct labour. Labour probably has been present some time, the membranes are ruptured, and any presenting fœtal part is blue and œdematous. The child is often dead. The mother is very collapsed and in continuous pain from uterine spasm, while the uterus can be felt as a hard, tender, dome-shaped mass, often showing a well-marked sulcus (Bandl's retraction ring) at the junction of its upper and lower segments. If neglected, death of the mother or uterine rupture will occur.

Many methods of treatment are recommended, but we unhesitatingly advocate immediate Cæsarian section, with subtotal hysterectomy if there is real danger of infection of the uterine cavity having occurred. This procedure is far safer in inexperienced hands than manipulations in the dark with instruments designed to destroy and so deliver the child, and it has the advantage of there being a faint chance of securing a living baby.

(*e*) **Ruptured ectopic gestation and tubal abortion** present very similar signs, which are mainly due to the severe intraperitoneal hæmorrhage which accompanies them, and call for urgent treatment to save life.

The condition is usually met with in young married women, who may have had previous normal pregnancies, often in rapid succession. The patient may or may not know that she is pregnant. For a few days or a week there may have been vague griping pains low down in the abdomen. After one or two missed menstrual periods, a slight blood-stained vaginal discharge will appear, and the patient experience a sudden sharp pain in the lower abdomen. Collapse rapidly ensues, and the patient becomes faint and deadly white. All the signs of intraperitoneal hæmorrhage appear, with the characteristic, slightly distended, non-rigid abdomen, which is acutely tender, especially on deep pressure. " Phrenic pain " at the top of the shoulder may occur from blood running up and irritating the diaphragm.

Pelvic examination usually reveals nothing save general tenderness, but sometimes if a previous partial abortion has occurred, which is not uncommon, a rounded, fluctuant mass can be felt occupying Douglas's pouch. This consists of clot and fœtal and placental tissue, and is known as a *pelvic hæmatocele.* Signs of early pregnancy will be seen in the breasts and vulva. Occasionally rupture may occur between the layers of the broad ligament (extraperitoneal rupture), when the signs of hæmorrhage are not so marked ; there is a pelvic mass and lateral displacement of the uterus.

The *diagnosis* should be easy if attention be paid to the extreme, often paper white, pallor of the patient, vaginal hæmorrhage and previous amenorrhœa. Occasionally, however, rupture of a pyosalpinx or ovarian cyst, perforation of an appendix or gastric ulcer, or a hæmorrhage from injury to some abdominal viscus may superficially simulate the condition. Hæmorrhage from an ovarian carcinoma or blood cyst may closely resemble rupture of an ectopic gestation.

The *treatment* consists in immediate laparotomy, through a low paramedian or transverse incision ; the peritoneum is found to be full of blood, and the hand, being introduced, grasps the affected tube and ovary and grips these tight to stop the bleeding. The rent tube is then brought to the surface, ligatured and removed ; the ovary is preserved if possible. The ovum and clot are sponged out and the abdomen closed. Once the bleeding is arrested, transfusion or gum-saline infusion should be carried out.

2. **Puerperal Infections. Sapræmia and Septicæmia** have been discussed on p. 970, and Ch. V., Vol. I.

3. **Salpingitis and pelvic peritonitis** are dealt with on p. 974, and Chapter XIII.

4. **General peritonitis** is fortunately uncommon in pelvic infections, but should it arise must be treated on the lines indicated (Chapter XIII., p. 538).

5. **Infection of fibromyomata** is usually from the bowel, and frequently, therefore, with gas-forming organisms. The patient is often extremely ill and suffers from abdominal pain and vomiting, while a rounded, tender mass is present in the abdomen. This mass can be shown on bimanual examination to be attached to the uterus. Treatment consists in laparotomy and removal,

if necessary with hysterectomy, but the prognosis is grave, as peritonitis and gas gangrene are liable to supervene.

6. **Complications of Ovarian Cysts.** (*a*) **Infection and suppuration** may occur, usually as a complication of some acute abdominal disease, such as appendicitis. The cyst becomes tense, tender and often fixed, and the temperature is raised. If the cyst has been known to exist diagnosis is easy, otherwise an abscess is usually suspected.

(*b*) **Torsion of the pedicle** occurs in small cysts, usually unilocular dermoids, and comes on generally after some muscular exertion. The patient experiences a sickening pain and vomits, while the abdominal muscles are tense. Later, as the blood supply becomes cut off, gangrene of the cyst may occur, and abdominal distension and peritonitis supervene. Often subacute attacks, with slight torsion, give rise to modified symptoms, the cyst becoming adherent to surrounding viscera. The condition may be mistaken for intestinal obstruction, but the tense, rounded and tender cyst is usually easily palpable ; or for appendix abscess, when the history should clear up the diagnosis (see pp. 543, 712 and 724).

(*c*) **Rupture** usually follows blows, when a large cyst is known to be present, and is followed by disappearance of the tumour, with some shock and often mild peritonitis. Occasionally gradual leakage occurs, with vague abdominal pain.

The *treatment* in all these cases is laparotomy (ovariotomy).

OPERATIONS ON THE FEMALE GENITALIA

These are performed with the patient in the Trendelenburg (for abdominal operations) or lithotomy (for perineal operations) positions.

Hysterectomy may be (1) *subtotal*, when the uterus is divided through the supravaginal portion of the cervix, or (2) *panhysterectomy*, when the entire organ is removed.

A low paramedian or transverse incision is made and the peritoneum is opened, care being taken not to injure the bladder. The intestines are packed off in the upper abdomen behind a towel, and the uterus grasped with a vulsellum forceps and drawn up into the wound. If the ovaries are healthy, one at least is left in situ. The broad ligament is clamped and divided between the tube and ovary, and then down alongside the uterus, care being taken not to damage the ureters, which cross alongside the cervix deep to the uterine arteries ; these latter must be picked up and ligatured. The peritoneum is now divided on the posterior surface of the uterus and stripped from it ; a similar proceeding is carried out on the anterior surface and the bladder separated from the cervix. The uterus and tubes are now free, and in subtotal hysterectomy the cervix is divided, hæmostasis secured, and the peritoneum sutured over the stump of the uterus. In panhysterectomy the vagina is opened and the whole uterus removed, the canal being left open, and the peritoneum united above it.

The abdominal wound is then closed in layers, after removing all clot and towels from the peritoneal cavity.

Wertheim's operation consists in panhysterectomy, together with removal of all the pelvic cellular tissue and lymph nodes. The ureters should be identified early and dissected out to preserve them from damage.

Cæsarian Section. A long paramedian incision is made and the pregnant uterus turned forward out of the abdominal cavity, which is shut off by towels. The fundus and anterior wall are incised vertically, the membranes divided, and the child delivered, the cord having been ligatured and cut. The hand is now introduced into the cavity, and the placenta and membranes gently separated and removed, the os being dilated by the index finger. The uterus now contracts, a process assisted by the application of hot towels. The wall is sutured by a series of mattress stitches of thick catgut and the abdomen closed. If required, subtotal hysterectomy can be performed.

Ovariotomy has been described briefly on p. 979.

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